SCIENCE

VOL. 87 FRIDAY, APRIL 15, 1938 No. 2259

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal
Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

PROGRESS IN HORTICULTURAL SCIENCE[1]

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THE American Society for Horticultural Science was organized some thirty-four years ago "more fully to establish horticulture on a scientific basis." At that time, the importance of scientific features in our profession was not so generally recognized, and there existed a definite need for stimulating activity in scientific research in the field of horticulture. The founders of our society entertained the hope that the technical papers presented at the meetings would be subject to close scrutiny, and they suggested, diplomatically, that this "would doubtless lead to a more complete investigation of some points imperfectly developed."

All of us will agree, I am sure, that some progress has been made during the third of a century of our existence, in realizing at least in part these objectives of our organization. The records of our annual proceedings give abundant evidence of this. There you will also find periodic summaries of the accomplishments in special phases of horticulture.

By focusing attention on the scientific features of problems in our field, the American Society for Horticultural Science has undoubtedly helped to bring about a general and sympathetic understanding of the need for more complete and well-rounded investigation in all phases of plant science. We especially welcome the attention given by the botanical and physiological societies to our field. Naturally, we hope that they will continue to help us in our endeavor "more fully to establish horticulture on a scientific basis" by using horticultural material whenever it proves suitable in the study of fundamental problems. But above all, we must continue to look to them for the painstaking and diligent research needed for the discovery of an increasing number of fundamental facts of plant life in general. No one realizes more than does the horticulturist, who must deal intimately and effectively with

[1] Presidential address, American Society for Horticultural Science, Indianapolis, Ind., December 29, 1937.

plants, how numerous are the gaps and how narrow and insecure the bases of many of our so-called principles of plant life. We are, therefore, naturally interested in the continuance of truly comprehensive, thorough and painstaking scientific work in supporting fields, regardless of its immediate economic bearing.

It is a source of pleasure to be able to record that the various horticultural industries and the public with whom we are in close contact have come more and more to appreciate our efforts in helping to throw light on their problems. They now confidently look to the professional horticulturists represented in this society to furnish scientific guidance in the solution of many of their practical difficulties.

The purpose in thus calling attention to the status achieved by our society during the past thirty-four years is to emphasize the fact that this imposes an increasing responsibility for progress on the present and prospective membership.

That there will be need for further progress in horticultural science is almost self-evident. With a larger population having higher standards of living and more leisure time for the enjoyment of luxuries and semi-luxuries, we may expect a greater interest in amateur horticulture and a larger demand for the products of horticultural enterprises. This will naturally call for more dependable and more intimate knowledge regarding the plants in our special field. To supply this increasing need is the object of horticultural science, which, with botany as its broad base, concerns itself especially with the life history, response and improvement of that limited group of plants intensively cultivated and grown primarily for the purpose of providing something more than bread alone to nourish the body and otherwise to enrich the lives of mankind by helping to satisfy the longing for beauty.

Many of the research projects in our field frankly aim to solve, or at least to throw light on specific and pressing problems concerning culture, storage or utilization of some particular crop growing in a particular locality. The horticultural scientist, however, does not hesitate, at the same time, to seek knowledge of the fundamental nature and processes of the plants he deals with. In doing so he is aware of the fact that our science is still young and that the small fragment of truth he may contribute will probably not affect present practices materially. He nevertheless has an abiding faith that an increasing store of well-organized knowledge will in due course of time be definitely useful in providing a more rational explanation for many plant responses or in helping to solve practical problems not yet formulated.

In thus dealing with plant life, the horticultural scientist remains conscious of the fact that his studies are directly concerned with the means that contribute to the health, the enjoyment and the economic well-being of a large part of our population. He recognizes that science may properly be interested in questions that seem far removed from immediate practical concern, but he is convinced that scientific methods may also be used effectively in dealing with matters that touch our daily lives. Such contact with practical affairs is by no means inimical to scientific work in the field of horticulture. On the other hand, it does provide frequent opportunity to demonstrate, outside the laboratory walls, the usefulness of the scientific attitude of mind, regarded by many as the most important mental acquisition of man, whatever his vocation may be.

The complexity of the problems with which the horticultural scientist must concern himself and the fact that he is thrown in close contact with those who on the average are probably better informed about the nature of their affairs than almost any other group of practical men, tends naturally to preclude a smug complacency. Without any thought of disparaging what has been done, we can not be satisfied merely to maintain the level of past accomplishments, but we continually seek to raise the standard of excellence in our profession.

Whatever the standards of this society are to be will be determined, not by strict rules and regulations nor by a rigid censorship imposed by autocratic authority, but by the individual scientist himself. Each, recognizing the obligation to advance the ideals of our profession, must discover his own limitations and find the proper remedies for his case. It is pertinent, therefore, to inquire what we as individuals can do to increase the quality along with the quantity of our own contributions.

To put ourselves in the proper frame of mind for such critical self-examination, we need only to remember that, while the methods of science are the best yet devised for solving the riddles of nature with which we in horticulture are concerned, such methods must be applied by scientists who, after all, are only human beings, subject to the limitations and fallacies of human nature in general. Unfortunately, not all human weaknesses have been entirely eliminated as yet by either science or scholarship.

The fact that science has learned from experience the very great difficulty of finding and recognizing the truth, and the extreme likelihood of error (Mulliken, SCIENCE, 86, No. 2221, 1937) should engender due modesty and humility as to the perfection of one's own contributions and opinions. "Untroubled certainty and assured consistency" may be vouchsafed only to those who are not wholeheartedly committed to the

scientific attitude of mind in the solution of their problems.

Among the questions that we may ask in humble and searching self-criticism, none are probably more important than those involved in a relentless scrutiny of our own work. I shall suggest only a few questions applicable specifically to the field of horticulture but more or less familiar to scientists in general, leaving it to your own initiative to extend the list and to supply the answers.

First of all do we fail to recognize the futility of being too impatient in arriving at a solution of a broad problem, or do we realize that it may be impossible as yet to reach a full understanding of all the questions involved? Have we resolved the subject of our inquiry so that it falls within the scope of our present abilities and the facilities of time and equipment required for a thorough investigation, or do we, perhaps, show the profoundest ignorance of the difficulty of the problem by attempting to encompass the entire field?

Are we always fully informed regarding the previous endeavors to solve the particular problem we have laid out for ourselves, or do we continue to thrash over old straw without much hope of finding really new kernels of truth? Have the methods we use in the laboratory as well as in the field frequently been tried out and found wanting as real means of giving us deeper insight into the problem? Do we keep up with the accomplishments of our own generation and are we fully aware of the trend of thought and discovery of new methods of approach in related as well as in our own fields? The fact that this becomes increasingly difficult is obvious, and it is equally obvious that it calls for more energy and industry on our part.

Are we too easily satisfied with incomplete observation and meager data? Are we sure that the observations are really valid for a given complex of conditions, and what do we actually know about the likelihood of obtaining similar responses in another season or during a period of years, or in another location?

Do we take too much for granted when we conveniently assume that except for the experimental treatment, all other conditions are uniform in field trials, or do we provide for frequent replications with numerous checks? In our chemical analyses are we satisfied when the duplicate determinations of a given sample check, or do we insist that there be careful analyses of many separate samples from different lots, so as to give some notion as to the range of variability within our material? Do we really understand the limitations as well as the possibilities in the application of the more modern tools of research, or do we perhaps use them merely to accumulate data and then try to find a reason why we should have taken all the trouble to get them?

Do we too frequently accept statements of others without inquiring into their foundation? Are we content merely to cite the author's own interpretation of his data, or do we evaluate the contribution as to completeness and validity of conclusions? Do we give too eager and perhaps unthinking credulity to so-called authorities, or do we question even them and reserve judgment until we are satisfied that nature in one of her whimsical moods has not put something over on the experts?

In our eagerness to snatch up new ideas and make use of the latest vogue of scientific interest, do we exercise great caution in testing them under a wide range of conditions before we definitely accept their implications? On the other hand, do we find difficulty in discarding hypotheses which we may have learned in our undergraduate days and which may still pass as verities in standard texts when they no longer serve to interpret the responses in the light of newer knowledge?

In reporting our results we may well look more critically toward the use of words to make sure that the meaning has been conveyed clearly and interestingly, but with due regard to the difficulties of expressing truth always smoothly and beautifully. In the preface to his book on North American orchards, Professor Chandler tells us that "truthful writing . . . must be as obscure as the facts are." By omitting all doubts and many qualifying expressions and frequent references to exceptions and limitations of our knowledge, a more convincing presentation could probably be made so far as the general reader is concerned. But the object of a scientific report "is not so much to convince as to cultivate critical analysis of the facts presented, and to stimulate further search for validity."

Is our presentation perhaps too simple, does it sound too sane, too true, or too eminently sensible and logical to fit in with the limitations of the actual facts in the case? Of course, we must inquire as to whether we have thoroughly sifted our facts and fancies and related them to some recognized even though tentative order of knowledge. Have we properly boiled down our material to the essentials, or do we confront the reader with "an appalling mass of material that is likely to bewilder him by its luxuriance and variety, but not to impress him overly much with system and synthesis"? As time goes on we will probably have to learn more and more to be content not to burden the records with all the minutiae of our many unfruitful trials and failures which may have aided greatly in our personal development, but which do not add

much to the store of well-ordered horticultural knowledge in general.

If we are striving for a more uniformly perfect record in the carefully cultivated gardens of horticultural science, we may have to rogue our promising selections of ideas and theories to free them from the hidden virus of wishful thinking, and we may still find it necessary to eliminate many weeds of misconception arising from long-lived seeds of prejudice or from those blown in by the strong winds of dogmatic assertion.

Many members of the society are engaged in teaching as well as in research. Theirs is a special obligation of providing for future progress in the attainment of higher standards of horticultural science by discovering specially gifted and promising individuals. They must see to it that these recruits are encouraged to become steeped in broad scholarship, and saturated with the spirit of inquiry, research and service that makes horticultural science significant. In emphasizing the need for thorough training in the fundamentals we are only propagating the ideals expressed by the founders of our organization, but we can now recognize more clearly than ever before that horticultural science may profit by a multitude of ideas, suggestions and experiences of many interdependent fields.

We may anticipate that the problems in horticulture will become increasingly difficult, since the public with whom we deal most closely has been educated to expect something more than a superficial insight. The modern concepts and explanations for horticultural problems may be better than the old, but we must acknowledge in all humility that they are still inadequate. It has been said of science in general that "the perfection of understanding toward which we are striving seems to grow more remote as it is approached" and again that "each scientific advancement only throws into clearer relief the mystery that remains." These statements apply with equal force to our field. The continuing need for something more comprehensive and more penetrating requires greater thoroughness than ever before in the development of skilled seekers after knowledge in our field.

The tasks of horticultural science, now grouped under floriculture and ornamental horticulture, vegetable gardening and pomology, will probably have to be divided still further to keep them within manageable units for effective attack. Such necessary specialization, however, needs to be accompanied by the broader vision afforded by a wider knowledge. The specialist must know "his stuff," but he must also know how to integrate what other branches of science may have to offer. He must know enough to appreciate the importance of contributions in the supporting fields, and his training in these subjects must be sufficient to enable him to distinguish between speculation and definite conclusions arrived at on the basis of facts. Consultation and cooperation with those in other fields will be more effective, and the advice given more to the point, if the problems can be stated intelligently in the technical language of the sciences concerned.

Presumably those whom we encourage to enter our field will have had some contact with the practical phases of horticulture. They will have made a creditable record as undergraduates not only in the courses dealing directly with the practical and economic relationships of their major subjects, but also in those dealing with general scholarship, and, of course, in the various supporting fields such as botany, genetics, soil science, plant pathology, entomology, bacteriology, physics, chemistry and mathematics. The horticultural scientist of the future will in all probability be greatly handicapped unless he knows more about some of these subjects than is generally required in good undergraduate courses. If he is to go beyond the point where he is likely to regard these sciences in more or less superstitious awe but can render only lip service as to their value for his particular field, he will need more advanced botany and genetics, more advanced chemistry, especially biochemistry, physical chemistry and micro-chemistry, and more advanced physics.

The student should not expect to find much in the advanced courses that is immediately or directly applicable to his chosen field, but he should acquire considerable mental satisfaction in knowing how one really discovers that things work more or less in accordance with some natural law and order. He will also derive lasting inspiration from knowing how to make use of these laws and methods in discovering still further secrets in his own field. Such training should help him to acquire skill in putting questions directly to nature in such a way that he can coax her into yielding answers that may be trusted within a minimum probable error. In addition, he stands to benefit enormously from the exacting discipline, the rigorous training in precise methods, accurate observations, clear thinking and critical inquiry that these subjects afford, especially in their more advanced stages.

The future horticultural scientist must understand that the experimental aspect of his investigation is something more than "mere puttering or blundering through." He must have originality based on an imaginative insight stimulated and controlled by contact with the older basic sciences. "Observation not guided by ideas is blind, just as ideas not tested by observation are empty."

To get far beyond the elementary stages of fact-gathering, the young horticulturist must be able to

approach the problems in his special field with methods characteristic of science in general. This involves among other things the intelligent use of refined instruments and mathematical tools of precision, to aid him in exact observations and fact finding. Such technique may be intelligently applied and appropriately modified for optimum use in the field of horticultural science only if the underlying principles as well as the limitations and the possibilities of these "aids to our infirmities" are understood.

In advocating a very thorough training of horticulturists in the underlying sciences, we are not unmindful that advances in our own field as well as in others may sometimes come about in an unexpected or an incidental manner, or even, in accordance with the laws of chance, as a result of hit-or-miss methods. By and large, however, only those whose training induces thoughtfulness and breeds well-balanced judgment and understanding are in a position to recognize that "they've got something there" if the unexpected or accidental happens. The greater the variety of fundamental subjects which the young horticultural scientist can effectively explore, the better his chances of greater accomplishments through either patient and systematical experiment or through so-called intuition or flashes of insight.

The motto of those whose duty it is to select recruits for our profession might well be: Let no one presume to enter the field of horticultural science unless he loves to work with plants and folks and has ability and the patience to acquire a thorough understanding of the basic and supporting sciences.

Such standing as our society has attained has been due in no small part to the ideals of scientific scholarship, fostered by our charter members, and carried forward by their pupils. We are especially honored in having as our guiding spirit and shining example the distinguished scientist and dean of American horticulture, Liberty Hyde Bailey. In a very real sense he has been the teacher of us all. As president during the first five years of its existence, he established the organization on a firm foundation, and helped to mold its policies for future usefulness. We are all grateful for his continuing and helpful interest in our meetings. Even though he has already passed the threescore years and ten allotted to the average man, his industry and enthusiasm for painstaking work might well tax the endurance of one half his age. His career as an inspiring teacher, an instructive and stimulating author, a helpful and sympathetic administrator of institutions and scientific organizations, and as a thorough, productive and untiring research scholar, will always serve as a challenge to workers in the field of horticultural science.

OBITUARY

GEORGE HENRY FALKINER NUTTALL

ON December 10, 1937, died in Cambridge, England, a scientific worker whose career was associated in significant fashion with an unusually large number of new scientific fields and of research activities in different countries. Nuttall was born in San Francisco on July 3, 1862. His father was a physician of standing; his sister Zelia Nuttall is widely known as an investigator of high rank in archeology. He was broadly educated at home and abroad, receiving the M.D. at California in 1884 and the Ph.D. at Göttingen in 1890. After four years on the medical faculty at Johns Hopkins and a little longer on the staff of the Hygienic Institute in Berlin, he went to Cambridge (Eng.) in 1899 as university lecturer, and was appointed in 1906 Quick professor of biology. There his research and writings in bacteriology, microbiology, entomology and transmission of disease led to the foundation and endowment of the Molteno Institute for Research in Parasitology, established in 1919; Nuttall was made its director and continued as such until he became emeritus professor in 1937.

Nuttall's work opened up new fields of importance in which at an early date he felt the need of journals to represent these growing activities and to publish the results of the work. Accordingly he established first the *Journal of Hygiene* (1901) and later as a supplement thereto *Parasitology* (1908); he edited both for many years. Firmly established, they now rank as leaders in these fields of research.

As an investigator Nuttall early won prominence in hygiene and the etiology of disease. Among the long series of his papers those on hygienic measures in relation to infectious diseases, on blood immunity and blood relationship, on the bacteriology of diphtheria, ticks, insects and disease, and canine piroplasmosis deserve especial mention as opening new and important lines of research in biology and medicine. They also show clearly his versatility and ability as a researcher. This pioneer work led to his appointment on many government commissions in the newly developing field of tropical diseases which opened up in the closing years of the last century and spread rapidly after 1900. His services were recognized both by various governments and by election to honorary membership in many academies and societies.

Nuttall often visited his native country, and here as elsewhere was warmly welcomed as counselor and lecturer. At various times he delivered the Herter lecture at Johns Hopkins, the Harvey lecture of the New