In general we may say that those persons who rank above 50 in the most essential traits give promise of achievement in a career in psychology.

Natural interest is another factor of which we should take account. A student seeking a career in psychology may have the opportunity of following his natural bent for interest in pure science or its applications to the educational, social, ethical, medical, artistic, and other fields of human interest in which he may find his natural bent.

Training

The study of psychology is usually begun in the second year in college; whereas many other subjects are begun in the high school or in the freshman year. As a result, it usually becomes a more advanced subject and there is more necessity for carrying it into graduate study. Most standard colleges and universities now offer good introductory courses in the subject, but beyond the elementary work, the student should seek institutions in which the particular phase of psychology that he desires to pursue is most adequately represented. The best is none too good for one who desires to specialize. In selecting, let the student choose, not on the basis of size of institution, but with reference to the men who are recognized as most worth while in a particular specialty.

As a prerequisite to a career in psychology, it is desirable that one should have command of French and German as a large portion of the literature on the subject is in these languages. He should also have pursued elementary courses in mathematics, biology, and physics. Other college subjects may be carried to advantage with, or in sequence to, an elementary course in psychology.

There is now a movement on foot to provide for the certification of psychologists. Such certification will be based on certain types of courses, usually covering about three years of graduate work, and will entitle the psychologist to practice within his field of specialization. Legislation covering such licensing is now being passed by dfferent states.

Psychology is a new science. In seeking advice, only those who are conversant with current literature and present movements in the subject should be consulted.

Types of Career

There are at present four distinct types of outlet:

Teachers of Psychology—The nature of this work and its opportunities are perhaps best known.

Scientific Research—The coming in of experimental psychology has opened up most fascinating new fields of investigation and many agencies furnish opportunity for a career as original investigator. The leading universities usually encourage this in connection with some teaching; but there are opportunities in universities, scientific foundations, surveys, and privately supported enterprises for persons who are unusually qualified for this type of work.

Specialists and Consulting Psychologists—Here the opportunities are most varied and new fields are opening rapidly as a result of research in each of the branches of applied psychology.

Technicians—All the specialists require technicians of various kinds as assistants. Most of these positions are, however, used as stepping-stones or apprenticeships in the gaining of experience for independent work.

Highly qualified advanced students can often find scholarships, fellowships, assistantships, and other financial provisions, given theoretically in recognition of some type of apprenticeship to graduate students. The remunerations open to persons who seek a career in psychology vary so much that figures would not be significant. In general, they depend upon the natural ability, the degree of training, and successful specialization.

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HORTICULTURE AS A SCIENCE[1]

Like most applied sciences, horticulture has evolved by very slow degrees from an art, governed by rules justified by experience, to a

[1] Read before the Association of Southern Agritultural Workers, Atlanta, Georgia, February 21, 1922

science based on laws or principles of universal applicability. The term "applied science" would seem to connote that these laws or principles are ascertained first and that they are then applied to specific conditions, but as a rule the applications are known and are practiced, having been hit upon by empirical means and the first function of an applied science is usually to "explain" them by discovering the principles involved. When a considerable number of principles have become established in this way, new applications for them are found and the applied science becomes in effect what its name implies.

A large part of the experimental work in horticulture has been conducted with the object of devising new rules and of ascertaining new facts of an empirical nature. More recently, however, considerable effort has been made to find principles of more or less universal applicability and this has been accomplished by a study of the fundamental factors determining plant growth and productivity. Though many valuable practices have not yet received scientific elucidation and though much good work remains to be done in the way of discovering new rules, a large body of well established principles has been accumulated and successful practice depends to an ever increasing degree on their recognition.

A comprehensive investigation of almost any horticultural problem involves much the same succession of stages as has been outlined for the development of the science; (1) The field for investigation is usually explored by experimental work of an empirical nature. (2) This is followed by scientific study to determine laws or principles. (3) This in turn is followed by more experimentation to test the feasibility of applying to particular conditions the principles that have been discovered. It seems customary to extol the scientific study which aims to formulate laws and to dignify it by some such appellation as "fundamental research." By implication, the attendant phases of investigation seem to be deprecated on the ground that they are largely empirical. However, this invidious distinction is unwarranted, as every investigator learns sooner or later, for these three aspects of investigation are like three links in a chain and progress in horticulture depends on their parallel development. Principles are of little value to the horticulturist if they cannot be applied, just as a collection of experimental data is of small import until it receives interpretation.

The strictly scientific aspect of horticulture is closely allied to botany and it is difficult to state wherein the distinction between the two lies. It is largely a difference in emphasis, since the horticulturist is interested only in those phases of botany that may be applied to his specific purposes. Nevertheless, the development of horticulture has followed closely in the steps of botany. During the last century the attention of most botanists was directed to morphology and taxonomy, a tendency reflected in the advances made by horticulturists in the subject of pollination and fruit setting and in the development and description of varieties. At present these subjects are better rounded and more nearly complete in their major aspects than almost any other phase of horticulture. Now that plant physiology is in ascendency, more rapid progress is seen in the nutritional problems of horticulture—in fruit bud differentiation, in pruning and in fertilizer treatments.

The dependence of horticultural science not only on botany but on other sciences as well may be illustrated by reference to recent work on the so-called Hardiness Problem. Although this has engaged the attention of both horticulturists and botanists for many years, until lately little was accomplished other than a substantial verification of the Laws of Temperature formulated by De Candolle nearly a century ago. Investigators were still faced with the seemingly contradictory facts that death from low temperature is due to loss of water from the cells by ice formation in the intercellular spaces and that nevertheless hardy plants usually contain less water than tender plants. What seems to be a satisfactory solution of this problem was made possible by some chemical investigations of Foote and Saxton at Yale University. This work showed that water may exist in different forms, and that the water held by colloids possesses properties different from those of "free water," particularly with regard to the temperature at which it freezes. This work suggested to Bouyoucos of the Michigan Agricultural College a classification of soil water into "free" water, which freezes at 0° C. or slightly below, colloidally adsorbed water which freezes at temperatures from a few degrees below zero down to -78°C., and combined water, which freezes only at temperatures below -78°C. This classification was applied by McCool and Millar to the water of plant tissues. The work of these investigators suggested an explanation of the greater tenderness of plant tissue with the higher water content. If hardiness depended not on the total water content, but on the content of colloidally adsorbed water which does not freeze at ordinary freezing temperatures, then a plant tissue might contain any amount of free water and still be tender, while a relatively small amount of water in the adsorbed condition would impart a considerable degree of hardiness. Recent investigations at the University of Missouri have shown that these surmises are correct, at least for some plants.

If hardiness depends on the amount of colloidally adsorbed water, what colloid holds it in this adsorbed state? Some botanical investigations by Spoehr of the Carnegie Institute suggested the probable answer to this question. He found that in cacti water-retaining capacity is correlated with pentosan content and that when the water-retaining capacity is increased or decreased by changes in environmental conditions, the pentosan content likewise increases or decreases at the same time. Pentosans were therefore investigated in fruit plants and vegetables and a correlation was found between pentosan content and hardiness. This correlation is remarkably close if hot water soluble pentosans only are considered. These findings indicate that certain pentosans, probably pectin-like substances, are the colloids that hold water in an adsorbed state. This is further substantiated by the fact recorded by Spoehr that dryness tends to increase the pentosan content of cacti and likewise their water retaining capacity. It is well known that cultural practices or climatic conditions that tend to dry fruit plants out in the fall, increase maturity and hardiness. Consequently the very conditions that lead to a low total moisture content probably increase the amount of water-holding colloids and the quantity of colloidally adsorbed water—hence the greater hardiness of plant tissues with the lower moisture content.

This understanding of the conditions associated with hardiness in plant tissues permits accurate outlining of the treatment or treatments that decrease susceptibility to low temperatures. It makes possible also an estimate of the magnitude of the effects that may be produced in that direction, and a recognition of their limitations. Such practices thus become incorporated in scientific horticulture.

This example indicates the intimate relation between progress in horticulture and progress in other sciences. Subjects which on superficial consideration might never be suspected of contributing data valuable for the solution of horticultural problems are seen to be worthy of study. If little headway has been made along certain paths of investigation, it is not infrequently because the methods, the facts or the technique essential to the solution of specific problems has been lacking. To this day, the official method for the determination of starch recommended by the Association of Official Agricultural Chemists is not an analysis for starch but for total hydrolyzable polysaccharides. Furthermore it is only within a comparatively few years that a satisfactory method for determining total sulphur content has been available. As a result, much painstaking labor has gone for naught, though some have noted, but have been at a loss to account for, the discrepancy between the results of such determinations and the unmistakable evidence of microchemical findings. The investigator can well afford to acquaint himself with recent advances in other fields and the broader his fund of information the more successful he will be. It might be suggested that progress in Physics, Meteorology and Forestry should be watched as well as that in various branches of Botany, in Chemistry, Soil Science and Agronomy. This task which would have been out of the question a few years ago is greatly facilitated now by the increasing number of abstract journals and substantial help is afforded investigators in many institutions by Plant Science Seminars, Scientific Societies and the like. Even though such conveniences be lacking much can be gained by personal contact with investigators in other fields and by a mutual exchange of criticisms and suggestions.

Treatment — that is, orchard practice, whether it be pruning, irrigation, fertilizing, thinning or what not—is an aspect of horticulture that may be compared to medicine, and the comparison is instructive because it indicates a possibility of development in horticulture from the application of scientific methods used by the physician or surgeon. Cultivation, pruning, the use of fertilizers and other treatments have been considered only in the light of one standard, the effect on crop production. The limitations of this one-tracked system may be demonstrated by reference to some recent experiments on fertilizer treatments.

If apple trees are bearing poor crops, a spring application of some quickly available nitrogenous fertilizer will frequently increase the yield. Such increases are very striking on weak trees, but some results obtained at Missouri show they can be obtained also on trees in good condition—on trees that are already bearing fair or even good crops. This effect of quickly available nitrogenous fertilizers applied a couple of weeks before blossoming has been shown to be produced by increasing the set of fruit. Fruit setting, however, is only one step in fruit formation. The process begins with the formation of fruiting wood and involves in succession fruit bud differentiation, bud development to the time of blossoming, pollination, fruit setting and finally fruit development. The failure or limitation of a crop may be occasioned by interference with any one of these successive processes. It would make little difference how favorable conditions might be for fruit setting, if fruit bud differentiation had not occurred. Recent investigations have shown that those conditions in apple trees, produced by spring applications of quickly available nitrogenous fertilizers, which are so favorable to fruit setting, do not favor fruit bud differentiation. Hence if poor crops result from deficiency in the initiation of fruit buds, spring applications of quickly available nitrogen would only accentuate the trouble.

This work reopens for investigation the entire orchard fertilizer problem which was thought by many to have been solved in the last few years by experimental work with sodium nitrate in the orchard. The same kind of fruit tree may present many different nutritional problems for treatment. Each problem requires special study and the remedy in horticulture, as in medicine, depends on accurate *diagnosis*. The use of fertilizers to correct the alternate bearing habit in apple trees constitutes a problem as distinct from their use in increasing the set of fruit as spraying peaches for San Jose scale is from spraying to control scab. As investigators, we are too ready to dispose of problems by assuming that either the nutrition, the moisture or the temperature relations are involved and that cultivation or the application of some fertilizer will lead to maximum growth and productivity. We would spare ourselves the effort of analyzing the problem—of making a diagnosis to determine the precise difficulty to be overcome. The time is not far distant when fertilizer treatments alone will be as numerous and as specific as all the horticultural practices recognized today. We must dispense with the idea of a mass attack on a bulk problem and apply more detailed methods, if we are to make rapid progress. Aside from technical improvements in such fields as spraying and marketing, the lines of pomological investigation along which greatest progress seems possible are treatment, propagation and plant improvement and treatment according to diagnosis promises to be one of the most fruitful.

There is no cure-all, no patent remedy for promoting growth, for inducing hardiness or for increasing crops. These can be accomplished only by careful study and hard work. No practice can be recommended for all circumstances or for all fruit plants, nor can the same practice be guaranteed to produce the same effects under different conditions. Treatment should be regarded not so much in terms of practice as in relation to the specific physiological processes to be affected. Much work must be done before specific measures to influence these different processes in the desired direction are found. Many practices that have not proved generally efficacious in the past may be shown to have great value for specific conditions. Pomologists must think in terms of limiting factors, and not merely in terms of the soil elements that may limit plant growth but also in terms of the physiological processes that may be limiting fruit production. For all this work, an accurate knowledge of the chemical changes associated with different physiological processes is of the utmost value because a thorough understanding of the conditions desired may suggest means for their accomplishment.

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A SUGGESTION AS TO METHOD OF PUBLICATION OF SCIENTIFIC PAPERS

The processes of scientific publication are admittedly in an unhealthy state. Various influences contribute to the acuteness of this condition, but it is likely that a time of stress has merely emphasized weaknesses inherent in the ordinary procedure for printing scientific papers. The "jammed" plight of the periodicals is slowing the vital current of new results. It becomes desirable to consider alternative methods of printing, perhaps better adapted to the present character of our needs. In this country and abroad several suggestions have already been offered; the most drastic of these has urged the publication of abstracts only, completed manuscripts to be deposited for reference in some central place—a scheme having so many unfavorable features as to merit little serious attention; it is not merely *results* we wish, but also some at least of the steps in their derivation.

I have in mind more especially the field of zoology. To-day this subject is specifically served by a fine group of journals, and by an "advance" bibliographic service of filing cards bearing author-abstracts. This system of publication is maintained through the cooperation of the Wistar Institute. These journals were founded some years ago, and each was designed to cover a particular group of zoological interests. They do not now correspond, in titles or in any individuality of contents, to major aspects of zoological development. Their fields of service overlap, sometimes to an embarrassing degree.

Investigators acquire separata of papers of particular concern to them. There is thus brought about a quite unnecessary duplication in the distribution of published work, and a proportionate waste of paper. Subscriptions for support of the journals are drawn from membership dues of the Zoological and Anatomical societies. Members therefore receive most or all of the journals, in this way accumulating a mass of unused, largely unusable, material; while still necessarily relying upon the convenient "reprint" for actual reference and use.

I believe that these difficulties may be obviated, and the course of publication simplified and expedited. With the hope of attracting discussion of this matter, I outline here a plan regarded as practicable and to the point. The foundation of new journals has little to recommend it; these are likely soon to suffer the fate of the older ones. Save in some special fields, the journal method of publication has become measurably antiquated.

The journals should be abolished. They do not represent rational subdivisions of zoological activity. There is no real reason why papers accepted for publication should be grouped to make up a "number." It is certainly more desirable that a paper be printed when it is ready for printing. If issued and originally distributed as a "separate," unnecessary duplication of distribution can readily be avoided. This plan requires some central agency, such as we now have, for handling the mechanical details of publication. Serial numbers could be assigned to papers as issued. An entire series might then be bound by libraries, though the more sensible way would