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CONTENTS

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THE UNIFICATION OF AMERICAN BOTANY[1]

A GLANCE at the history of botany in America shows that on several occasions special branches of the science have attained prominence, have separated from the parent stock and taken independent root. These offspring are now counted as separate sciences which yield little or no allegiance to the parent stock, and whose devotees no longer call themselves botanists. As examples we may mention bacteriology, forestry and the group of agricultural sciences represented by agronomy and horticulture—all subjects essentially botanical, with large and active corps of workers, but belonging to botany no longer.

This dissociation is undoubtedly the natural result of the growth of botany and the development of its several fields, each of which, as it assumes a position of special importance, develops more or less of autonomy and sometimes independence. Other sciences show the same tendency, and I shall not attempt to decide whether botany shows this trend toward dissociation to an exceptional degree. The questions of immediate importance to us are: What are the causes of this dissociation? Are they still operative? What new developments may be expected? How far can the process go without serious injury to botany in general? Can the tendency be overcome in whole or in part? And if so, how? It is fitting that these questions should receive the serious consideration of all botanists at this time for the future is heavy with possibilities. The changes of reconstruction may prove to be more fundamental than those of war, and the responsibility

[1] Invitation paper before Section G of the American Association for the Advancement of Science, in joint session with the Botanical Society of America and the American Phytopathological Society, Baltimore, December 26, 1918.

for American botany during this period of flux rests upon the botanists themselves.

That the tendency amongst botanists toward dissociation is too strong to be disregarded is shown by an examination of the recent botanical programs of these winter meetings in comparison with those of a few years ago. Formerly all botanists met with Section G of the American Association for the Advancement of Science, and with the Botanical Society of America for the reading of papers on miscellaneous botanical subjects. Now, the plant pathologists, the geneticists and the ecologists have independent societies; the physiologists and systematists have separate sections of the Botanical Society with independent programs; and still other groups of botanists are beginning to request recognition and to urge that special sessions be devoted to their subjects. The grouping of papers according to subject matter and the formation of special programs are made necessary by the rapid increase in the number of papers presented, and doubtless are desirable in every way. The formation of different sections by the Botanical Society of America, and even the launching of independent societies by various groups of botanists, are the natural results of rapidly mounting numbers and of increasing specialization.

There is no question but that the evolution of our winter programs indicates healthy growth, yet we must recognize the lurking danger, for we see here one evidence of the centrifugal tendency amongst botanists. Separate programs denote and foster a concentration of effort along special lines. They are one sign of our inclination to segregate into groups, the special subjects in which we are interested acting as the foci of attraction. This segregation, within proper limits, undoubtedly makes for efficiency, but we must take care that it does not lead to undue slackening of interest in other botanical fields than our own, to loss of perspective and to inability to grasp other points of view. If this occurs we shall have crossed the danger line, ultimate estrangement amongst botanists becomes a mere matter of time, and efficiency will give place to disunion and narrowness. Botanical science could not then be compared with a healthy tree surrounded by vigorous offspring in the shape of subsciences; rather would it be likened to an ancient trunk denuded of many of its most important branches which have struck root for themselves and are now selfishly competing with one another and with the impoverished parent stem.

Our problem then is to preserve the unity of American botany without losing the benefits of specialization. It is the old problem of controlling and directing the vital forces which underlie growth and development that they may make for efficiency and strength rather than for disunion and weakness.

I believe there is one factor more potent than any other in promoting disunion amongst botanists. That factor is not the fundamental scientific importance of a given field of botany, nor the speed of its development. We have seen the rise to importance of one subject after another without witnessing their withdrawal from the botanical hearthstone. It is not the development of a peculiar and highly specialized technique, nor the concentration of interest in a particular group of plants. Neither is it mere number of workers in a given field, nor close affiliation with non-botanical subjects. All these factors contribute to dissociation *within* the ranks of botanists, but do not necessarily lead to rupture of those ranks. Perhaps not all combined are so potent in this respect as is economics. Whenever any branch of botany becomes of especial economic importance its centrifugal tendency is enormously increased. The general public is then interested and becomes instrumental in determining the course of development. There is a new and greatly enlarged staff of workers, many of whom have not received orthodox botanical training. These workers in the new field of applied botany lose the isolation of the pure scientist, and come more closely in touch with the problems of human life. New methods of thought appear and new standards of value arise. While the applied botanist is developing the ideals of service to his fellow men, he often over-emphasizes the importance of his own field, loses his catholic interest in botany in

general, and then gradually withdraws from the fellowship of pure botanists.

But the pure botanist is not without fault, for he too often matches the narrowness of the applied botanist with his own intolerance. I have seen mycologists bored to extinction while pathologists excitedly discussed the effects of a serious outbreak of late blight of potatoes, and only become interested when the discussion turned to the morphology of *Phytophthora infestans*. Surely no science is more closely bound up with human life than the study of plants, which furnish us food and drink, shelter and clothing, and supply so many of our other needs, physical, intellectual and esthetical. Yet botany has appeared to dread the economic taint and has seemingly endeavored to keep its skirts free from the stain of the soil in which plants grow. Certainly she has allowed the applied branches to struggle on without the full benefit of a mother's firm yet tender guidance, and too often has repaid the waywardness of the child with aloofness and neglect.

Separations which have occurred already in the botanical field probably were inevitable, and perhaps were for the best interests of the subjects concerned. But there can be no doubt that further divisions would be disastrous. More than that, at this time when botany should face the future with a united front, we can not permit the forces of disunion to go unchecked and any divergences which now exist amongst us must be abated. Such divergences do exist and if neglected will increase in extent. The immediate danger point is found, I believe, in plant pathology. That pathologists have been growing apart from other botanists there can be no doubt, and I have not yet observed any extensive effort on either side to stay the process. Certain conditions surround plant pathology unlike those pertaining to any other branch of botanical science, and some of these conditions make for disunion. In briefly presenting some of these features for your consideration this afternoon I will speak of pathologists on the one hand and of botanists on the other. This distinction is merely for convenience. Pathologists are botanists still, and it is my earnest hope that they may always remain so.

Plant pathologists constitute the largest single group of botanical workers, and the only large group directly connected with the economic field. The latest printed lists of members show 384 names in the roll of the American Phytopathological Society, and 630 names in that of the Botanical Society of America. One hundred and eighty names are common to both societies, making a total of 834 names on both rolls. Of these 834 names, 384 or 46 per cent. belong to pathologists, or to botanists, largely mycologists, who are sufficiently interested in pathology to join the American Phytopathological Society. These facts are worthy of attention. Pathology is not only one division of botany, it is by far the largest division, it is a young division, it is growing very rapidly and must continue to grow rapidly in the future. As a result most pathologists are young, with the zeal and enthusiasm of youth and of expanding opportunity.

Another important fact to be noted is that pathologists constitute a remarkably homogeneous group as compared with the diversity amongst botanists. Plant diseases show almost infinite variety and the problems they present are equally varied. Yet whatever their previous training and experience, whatever the requirements of their particular problems, all pathologists speak the same language and think in the same terms. All recognize that they are working toward the same end on different phases of the great disease problem. Hence there has arisen a community of interest amongst pathologists unknown among botanists and impossible for them to develop. Pathologists are rapidly forming an esprit de corps which is an asset of the greatest value and will prove to be a powerful factor in future development.

The rapid growth of phytopathology in importance during the past few years has brought the pathologist more and more closely in touch with both producer and consumer of plant products. The world war has greatly increased his responsibilities in connection with the food supply. He has taken his place on the battle front of world action and more and more is losing the independence of the botanist as he

takes up the life of public service. He is drifting away from botanical fellowship, for circumstances have given him little time for mental adjustment, and for the throwing out of adequate anchors. So we have at the present time, this large and rapid growing body of botanical workers, remarkably homogeneous, with unusual esprit de corps, closely in touch with human life, which is drifting steadily away from the botanical standards and ideals of the past. Can either botanists or pathologists permit the drift to continue?

Pathologists are already losing much through lack of close association with other botanists. The demands upon pathologists have been many this past year on account of increased responsibilities, while their ranks have been depleted by the call of many of their number to military service. Teaching, laboratory research, field work, the ever-increasing demands of the extension service, all combine to give the harassed pathologist no respite. The future promises little hope for greater leisure because the world requires food. Although pathology is receiving increased financial support and additional helpers are rallying to her assistance, these additions barely keep pace with the ever mounting responsibilities. The pathologist must look forward to a life harassed by the multiplicity of problems insistently pressing for attention. Oftentimes he will be forced into print prematurely due to public and administrative requirements. Therefore, he must guard constantly against becoming hasty, superficial and narrow. He will need the broadening contact with the classical and fundamental work of other botanical fields. He will need the steadying influence of the greater leisure and consequent independence of the pure botanists. He will need their active assistance in the solution of his problems.

Botanists too have much to gain from close association with their pathological colleagues. Pathologists constitute the largest single group of botanists. They are virile and alert. They have the energy and spirit belonging to a young science. They possess the lofty ideals and contagious zeal of public service. They are in close touch with the throbbing pulse of human life and can furnish this valuable contact to other botanical workers. Botanists have watched the economic branches of their science develop one after another and slip away from their fellowship, while they themselves have stood by, either helpless or indifferent. This has gone on until many botanists now appear to regard applied botany as a thing apart, perhaps of a lower order, in which they may properly take only an academic interest. What an error! How can the virility of any subject be maintained except by human contact? Is not service the highest standard and the greatest activator? The value of any discovered truth is in the end determined by its usefulness, by its connection with other facts already known or yet to be discovered, and by its ultimate power for the uplifting of the world, physically, intellectually and morally. Scientific research for its own sake gives but a selfish joy, and may lead in the end to dry rot and to the scrap pile of human progress.

The progressive divergence of botanists and pathologists may well cause concern, but it has not yet become irremediable. The forces that make for dissociation can be overcome and closer union secured, but not by resolutions nor by legislation. There must be a general realization of the situation by both botanists and pathologists, followed by persistent effort at many points. I wish to suggest two important lines along which we should work.

In the first place, we should broaden our college courses in both botany and pathology. There has been extensive discussion in the English journals during the last few months on the botany to be taught after the war, and articles on the same subject are beginning to appear on this side of the water. It is urged that the teaching of botany should be broadened, that the elementary courses especially should not aim to instruct the student in botanical science, but rather to interest him in plants and in their manifold relations to his daily life. I shall not enter into this discussion except in so far as it concerns the subject before us.

I have listed the alma maters of 224 persons

actively engaged in pathological work, whose records were available. These persons are of various ages, are located in all parts of the United States, and the number is sufficiently large to be representative of the entire body of pathologists Of these 224 persons, 64, or 29 per cent., graduated at state agricultural colleges, 116, or 52 per cent., at universities which include colleges of agriculture, and 44, or 19 per cent., at colleges and universities without direct agricultural connections. I did not include in the above count those botanists who have been drafted into pathological service during the past few months on account of war conditions. These workers are of varied origin, are of all degrees of pathological training, and doubtless will largely resume their former positions with the return of normal educational conditions. Of the 44 pathologists listed as graduating at non-agricultural colleges and universities, over a third hail from a single institution, and a number of the remainder belong to the older group of pathologists who were trained as botanists, and entered the pathological field during the early period of its development. It appears then, that during the years preceding the war non-agricultural colleges and universities, excluding the single institution mentioned above, furnished less than 10 per cent. of the pathological workers of the United States. Is this a fair proportion? Why are so few graduates of our old-time colleges and universities entering the rapidly expanding field of plant pathology?

An examination of the curricula of these institutions is illuminating. Many of them offer no botany at all, or only elementary courses which are often labelled biology. Most of the institutions which possess departments of botany offer only standard courses in certain fundamental botanical topics and pay little if any attention to practical phases of the subject. Pathology as such is nearly, if not quite absent, and you can count on one hand with fingers to spare the institutions which give more than a passing consideration to mycology. Physiology, a subject of rapidly increasing importance to all branches of applied botany, fares only a little better than mycology. Botanical classes are usually small, graduate students few, and general interest in botany as a living subject undeveloped. The old botany of the schools and colleges is too narrow for the present day. Morphology and evolution are the backbone of most of these courses, and of nearly all text-books. But evolution needs no champion to-day, and botany taught from that standpoint alone does not appeal to American students. We need courses with a new method of attack, and text-books written from a new point of view. Botanical courses must be made more human. They must be squared with the progress and problems and life of to-day, even if this means radical revision of both methods and subject matter, and the surrender of some of the accepted standards which have served us indifferently well in the past. Fortunately there are all kinds of botanical subjects to interest all kinds of people, and with judicious selection elementary courses may be made to appeal to the many, rather than to the few. We must abandon the notion that the study of botany is a summum bonum, a choice privilege to be accorded only to the elect. The average student and the ordinary citizen must know botany, and must be aroused to an interest in plants as one of the most important elements of their environment. Only if this is done will the botany of the future achieve the importance it deserves. The responsibility for this vitalization rests largely on the undergraduate colleges. They must see to it that botany lives down its reputation of being an unimportant study for students who hope to become red-blooded men of affairs. They must not permit botany to be separated from the great field of agriculture which rightfully is hers. As well might chemistry withdraw from the industries, or mathematics deny mechanics and engineering. Botany has failed to qualify as an important subject during the emergency period of the war. Let us ask ourselves, is botany really unimportant to the nation at this time of emergency, or have botanists permitted it to appear so?

If now we turn to the curricula of the colleges of agriculture we find extensive courses

in pathology, in horticulture and in other branches of applied botany, but mycology, physiology and other fundamental botanical subjects too often receive inadequate attention. Specialization easily goes too far, and the product is a pathologist who is not also a botanist; he is a specialist with too narrow a training, with a foundation too restricted to permit the breadth of vision and the resourcefulness necessary for the adequate handling of many pathological problems.

Although these criticisms are not of universal application, I believe it is in general true that while the colleges on the one hand have been holding aloof and have not broadened their courses to include the modern applications of botany, the agricultural institutions on the other hand have specialized too strictly and have laid too little stress on the fundamentals of botany. Both tend to dwarf their students and practically restrict their graduates to their own fields, thus increasing the divergence between botanists and pathologists. In the future we shall need both botanists and pathologists. In addition, for the solution of many disease problems we shall need pathologists with a broad botanical foundation. These workers naturally should be trained by the colleges of agriculture. And we shall also need morphologists, physiologists, geneticists and ecologists with extensive knowledge of pathology, who naturally should be trained by the non-agricultural colleges and universities. When such a corps of workers is at hand, we shall not only have tremendously advanced both pathology and botany, but we shall have obliterated all distinction between the two subjects and made segregation into two groups of workers impossible.

A second vital force to draw together pathologists and botanists is cooperation in research work. The study of any plant disease is many sided, involving not only the study of the parasite and its effects upon and relation to the host, but the study of the host itself and of its varied relations to its environment, both in health and in disease. Not all pathologists are equipped to undertake certain of these problems which call for special training. Moreover, most pathologists, with manifold demands upon their time, are able to give attention only to the more immediately pressing features of the many problems before them. Hence their research work is perforce fragmentary and few diseases receive full consideration in all their phases. This procedure is faulty both from the scientific point of view, and in the end from the economic point of view as well, but it is made necessary by the pressure on the time of the pathologists and by restrictions on the use of public funds. The field of plant pathology is full of problems, morphological, cytological, physiological, ecological, genetical, which should receive attention, but whose solution is not in sight unless our botanical colleagues come to the rescue.

Many botanists in the colleges and universities could profitably take up this work. In choosing their research problems botanists have left the pathological field entirely to pathologists. In their desire not to encroach on the pathologists' domain they have avoided economic host plants to a large extent, and have turned away from cultivated fields and sought their material in woods and swamps. It is quite possible that by so doing they are sometimes passing by the material best suited to their purposes. Why should not geneticists breed economic plants more extensively and while determining the laws of inheritance, also produce improved strains of food plants? Why should not anatomists, cytologists, physiologists and ecologists study the potato or the cotton plant in health and in disease, and while conducting researches of fundamental scientific importance, be making needed contributions in the pathological field? Many of these pathological problems are suitable for master's and doctor's theses, and the fact that the problem has an economic flavor will, in the case of many students, give added zest to their work.

During the past year the pathologists, under the leadership of the War Emergency Board of the American Phytopathological Society, have inaugurated cooperation in research work to a degree which had been deemed impossible, so that the movement has attracted the attention of other scientific men. The pathologists

now propose to carry the get-together enthusiasm of the war over into peace times, to continue to foster the spirit of cooperation and to increase pathological efficiency by coordination of effort where such action is possible and desirable. It is clear that such a movement can not be forced, but must be allowed to grow under tactful management. The Society has therefore appointed an Advisory Board of six members to continue and foster the work initiated by the War Emergency Board. Can not the cooperative movement be extended to include other botanical workers? There are doubtless many botanists in the colleges and universities, especially those more or less isolated from botanical centers, who would gladly participate in cooperative projects. The problems are many, and there is no question but that pathologists will welcome most heartily the assistance of their botanical colleagues. It is probable that in many cases cooperation can be inaugurated most readily by conferences between individuals, especially on the part of workers in the same or adjacent regions, as the contiguity will ensure common interest in local problems, and will facilitate exchange of material and of ideas, and comparison of results. The Advisory Board will be glad to assist whenever possible by providing opportunities for cooperation and by facilitating the arrangements.

Botanists and pathologists are excellent complements of one another. In their closer union lies strength for the upbuilding of our common science in the momentous days which lie immediately before us. Of all the great nations of the earth we have suffered least from the ravages of the world war. We have felt its stimulus, but escaped its devastation. Hence the world is looking to America for leadership in many lines, and botany is one of these. We have the opportunity. We have the men. Have we the spirit? And can we supply the leadership? German domination is for the moment gone, but it will surely reassert itself if we are inactive. We must examine the bases on which German dominance in the field of botany has rested, and supply those factors which we now lack. We must write texts, compendiums and monographs to replace the German works which we are now using, and which we must continue to use indefinitely unless we ourselves write better ones. We must disseminate knowledge of botany amongst the people that we may receive the support which will enable compendiums to be written and research to be developed properly in both pure and applied fields. We must broaden our teaching of botanical subjects that we may produce not merely specialists, but the broad gauge men of wide perspective who shall be our leaders. We must stand together as botanists all, whatever our special field of endeavor may chance to be. If we do these things, and we can do them if we will, America will assume the commanding position in world botany.

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THE ELEMENTARY COURSE IN ZOOLOGY—IS IT SATISFACTORY?

AMONG the problems presented to the National Research Council by the government was one conveyed in the request of the War Department for the preparation of outlines of courses adapted to the conditions of the proposed Students' Army Training Corps. Like other divisions, that of biology undertook the work assigned it and formulated a suggested course. This was not printed and distributed in time to come into use, so that this effort of the council was entirely abortive. Since, however, biology was one of the subjects listed by the War Department's Committee on Education and Special Training, elementary biological courses of an intensive character were given in many institutions. It was the desire of several divisions of the council to determine the value of the educational experiment presented by the unusual requirements of the government's program. But unfortunately the conditions of the experiment were so disturbed by delays in starting work, by the occurrence of the influenza epidemic, and finally by demobilization of the corps before the completion of the first term, that no estimate could be placed upon the value of the results obtained from the operation of the novel