

SCIENCE

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FRIDAY, OCTOBER 24, 1902.

THE CARNEGIE INSTITUTION.

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ONE of the cardinal difficulties which must, I take it, be met speedily by the administrators of the Carnegie Fund (and the present discussion may aid in showing what some of the difficulties are) is the problem how to divide its benefits fairly. For, according to the deed of the benefactor, the purpose of the gift is evidently to stimulate science in its widest acceptance, in all of its branches, applied, no less than theoretical. And to expend its goodly income on lines which will be in fullest keeping with the trust is by no means an easy task. Its trustees are bound to distribute its benefits fairly, but they may well be puzzled by the number and kinds of questions which require a practical answer. They have thus immediate opportunities for investment, which are legitimate, attractive, and which may never befall them again—e. g., the acquisition of the Woods Hole station. They have also to deal with the importunate and well-deserving (colleges, societies, experimental stations, journals and individuals), some of whom, I fancy, are aggrieved at not having already received an annual sop from the Carnegie funds.

As a matter of fact, however, the Institution, in spite of its ten millions of dollars, is yet too poor to yield the immediate and miraculous draught of scientific results

which many of us expected. For science in these days has so many branches that the Carnegie funds will be able to increase—as far as funds can—the yearly scientific activity, as Professor Cattell estimates, by only about one per cent. There are, roughly speaking, about thirty main departments of scientific work, and computing the income of the Institution at \$300,000, the share of each department could hardly equal \$10,000 a year. Moreover there is the important question of expense of administration to be considered. Some have even suggested that a central organization be amply housed, and at considerable expense. But I for one fail to see that such an outlay would be for the greatest good of the scientific community. It would be rather a delectable than an all-important thing to have a well-built and splendidly equipped Carnegie headquarters in Washington, with a corps of high-salaried officials to give public lectures and to supervise select laboratories—at an expense of at least half the income of the institution. The main benefit in such a plan would, it seems to me, be too nearly local and individual to prove in best accord with the highest purposes of benefiting science. On the one hand the officials, chosen for eminence *after* they have done their major work, would, before many years, become quasi-pensioners, and unless they were removed ruthlessly, say by an age limit, they would soon cause the Institution to lose touch with recent developments and recent needs in science. And on another hand the Institution is not wealthy enough to run any risk of acquiring a political environment, or of evolving a highly specialized bureaucracy. And this risk is the less needful since the average investigator is apt to work for the benefit of the cause, unaffected by the stimulant possibility of some day being promoted to Washington with a salary of \$10,000, to sit in a conspicuous chair, and perhaps as

time goes on to have a gold-braided coat, frogged with gold acorns. Contrariwise, I feel strongly that the great purpose of the Institution would be best served if there were as little salaried officialdom as possible for the actual administration of its affairs. And I fancy that very few of the eminent scientists who are invited to become members of the committee, will refuse to act, and to act zealously and effectively, because they are not paid.

The fair-division problem of the trustees, then, narrows itself down to this: What branches of science are to be looked upon as equivalent candidates for benefits? And which ones are to be favored to the detriment of others? And for what reasons? Looking over a classified list of the 'sciences' one can readily select thirty branches, each of which, like electrical physics, or morphology, or organic chemistry, or psychology, or paleontology, would make the best of use of a Carnegie dividend. And a trustee would probably be embarrassed to have to pare down one of these branches for the benefit of the others. There is something to be said in favor of establishing a pro rata scheme of appropriations for the branches in accordance with a census of the number of worthy investigators which each branch includes. But, on the other hand, there are weighty reasons why such a plan would be inexpedient, since the number of workers may be out of proportion to the importance of their results, tested from the scientific standpoint. But here again is the difficulty of setting up an accurate standard of comparison. In any event there could be made a satisfactory division of science into approximately equivalent branches, say to the number of twenty-five or thirty, and for each of these an honorary committee be chosen. And the Institution, by the testimony of such expert committees, could be reasonably sure that its annual appropriations would find their

way where they would do a maximum of good. And each sub-committee could, it seems to me, best decide what share of its grant should be used for publication, individual grants, exploration, prizes for special themes of research, etc. So, too, to what degree a new or retarded division of its activities should be fostered to the detriment of an older and better equipped one.

In the matter of the character of work which it should be the general policy of the Institution, *i. e.*, in every branch, to provide for, I would suggest as most important: (1) publishing, (2) facilitating bibliographical work, (3) procuring material for research, (4) granting funds or fellowships. And the list could be readily increased.

1. *Publishing*.—One estimates conservatively, I believe, in affirming that *there are to-day enough worthy researches of American investigators to warrant the expenditure of the entire income of the Carnegie funds for purposes of suitable publication*. It has recently been suggested that American publications would be greatly aided by the establishing of a Carnegie bureau of engraving and printing which should execute at favorable rates the work of various societies. Such well-intended means, however, would bring with them certain practical drawbacks, and, judging from precedents, one would not be surprised if the output of the establishment became more costly and less efficient than that of skilfully directed private enterprise. More useful in practice, I fancy, would be direct grants for publication, say to periodicals of the stamp of the *American Journal of Morphology*, and permission of Congress for lithographic work to be brought through the customs free of duty when sanctioned by the Institution. The longer, more important, elaborately illustrated and carefully selected memoirs might appropriately be brought out by the Insti-

tution, and a splendid series of quarto and folio volumes would be a fitting fruit of our national work, to be to us in time what the *Philosophical Transactions* are to the British. And such publication I place among the very foremost needs of American science. We need hardly recall that for publication of zoological memoirs, to take an example, American authors have had either to accept the charity of foreign journals or to allow their researches to remain unprinted.

2. *Bibliography*.—All workers in science need skilful and energetic help in the thankless drudgery of reference hunting. To give them necessary aid the Institution should at once subsidize the Concilium Bibliographicum, an American enterprise, supported largely by the charity of Switzerland. The Concilium lacks only funds to enable it to extend its excellent work into various departments of biological science. Its work in zoology is invaluable. In connection with such a bureau it may be possible for the Institution to publish a series of bibliographical volumes (on the lines of the recent paleontological work of Dr. Hay) which will be a permanent boon to students in all branches of science. Another bibliographical development, in connection possibly with the Concilium, is a bureau to provide applicants with necessary literature lists; also a bureau in correspondence with libraries to place in the hands of investigators works of reference which cannot be procured by local means.

3. *Research Material*.—In some lines of research this can be secured only with considerable outlay. Thus for an important embryological study a sum of from five hundred to ten thousand dollars is not an uncommon expenditure. In this country such expense has usually been borne by generous outsiders or by investigators themselves; in rare cases universities or societies have contributed. In Europe,

however, societies have usually furnished appropriations, and in America, other calls permitting, the Carnegie Institution might justly follow their example. On the other hand, the maintenance of laboratories appears to me of less immediate value in encouraging research, for there now exist many and well-equipped laboratories in connection with university work throughout the country, open, too, on generous terms to any qualified investigator. The question of the Woods Hole station is, I think, exceptional, since nowhere else in the United States can marine investigations in all fields be carried on to similar advantage. Special experimental stations, however, for statistical and other variational studies are not as immediate a need since most of their work can be carried on in connection with the agricultural schools of many states. In this regard the history of foreign universities teaches us that research will flourish in spite of the lack of modern and splendidly equipped buildings. Men and books are at present less prevalent in our country than are tolerable quarters in which to house them. In no event would a Carnegie laboratory, I believe, be warranted in supporting classes for instruction as long as worthy investigators are in need of books, research material and means of publication.

4. *Grants and Fellowships.*—When the foregoing needs are suitably provided for the creation of fellowships would give very desirable means of stimulating activity in research. And in this matter one endorses heartily the suggestion of Professor Cattell in his recent paper in *SCIENCE*. None the less it is still a question whether, money being limited, more productive results would not follow the system employed by various trust funds of granting definite sums to deserving investigators to enable them to complete definite pieces of work.

COLUMBIA UNIVERSITY. BASHFORD DEAN.

Most startling was President Harper's statement that Mr. Carnegie's gift of ten millions to it had injured Scottish education. Most disquieting was his view of the Carnegie Institution as a possible peril to science.

I venture to make public some brief hints of views as to how this great Carnegie Institution can contribute most effectively to the advancement of science. We speak of the endowment of research, but the real object is to bring to pass in the highest degree, to get started and carried to fruition, scientific creation, creative scientific achievement.

The payment for, the reward of, scientific productivity after it is over, is only a comparatively worthless parody of this supremely important aim. To have given Lord Rayleigh, already very wealthy, ten thousand dollars for having discovered argon was a pitiful waste of the money, almost painfully puerile.

Suppose the Fish Commission should spend its appropriation in pampering certain especially agile and powerful fish? What it did was to seek the point of danger, destruction and waste in the life-history, and in safeguarding these, make valuable its energies.

With the possible scientific creators also the loss is greatest just at the start.

Of those gifted with scientific genius, many allow that genius to atrophy, the potential never becomes actual; perhaps the scientific career is deliberately rejected in favor of money-making.

This choice of career is largely, almost instinctively, a matter of attractiveness and safety.

Such a spectacle as the ejection of the Cincinnati professors, such a recurring spectacle as one of them passing through the streets and known to be unable, though highly worthy, to regain a foothold in the

on-go of paid science, strangles local scientific research unborn.

And if the keenest, brightest, most gifted of the young people reject the scientific career, then fellowships serve only a dull, stale, tired clique of incompetents.

Even after the possession of the rare and precious gift of scientific genius has been clearly, competitively proven, the possessor may choose what he considers a safer, more paying, more attractive career. I was twice Fellow of the Johns Hopkins University and among my contemporaries two, unsurpassed in gifts for scientific creativity, deliberately went over to money-making.

And finally among the sifted few who have the divine gift and the divine appreciation of their gift, the exquisite bud in its tender incipency may be cruelly frosted.

Of the great Hilbert's 'betweenness' assumptions one was this year proved redundant by a young man under twenty working with me here, and by a demonstration so extraordinarily elegant and unexpected that letters from high authorities came congratulating the university on the achievement. Professor E. H. Moore, of the University of Chicago, has published his congratulatory letter spontaneously written (*Amer. Math. Monthly*, June-July, 1902, pp. 152, 153).

This young man of marvellous genius, of richest promise, I recommended for continuance in the department he adorned. He was displaced in favor of a local school-marm. Then I raised the money necessary to pay him, only five hundred dollars, and offered it to the President here. He would not accept it.

The Carnegie Institution is bound, I think, in order to promote most manifoldly scientific productivity, to consider such prenatal influences molding, making or unmaking the potential man of science.

As a practical application of such line of thought, this would favor the Woods Hole laboratory retaining its independent position and popular organization.

Men of science should never voluntarily take away from men of science the highest and finally responsible direction of scientific productivity.

The bane of the state university is that its regents are the appointees of a politician.

If he were even limited by the rule that half of them must be academic graduates, there would be some safety against the prostitution of a university, the broadest of human institutions, to politics and sectionalism, the meanest provincialism.

Just so scientific journals should be absolutely controlled by scientific men, independently or in connection with scientific societies.

So the purchase by the Carnegie Institution of the *American Journal of Morphology* would appear ill-advised. The paramount aim should be to help, not to dominate.

Everything in a completely subsidized journal is taken at a discount. Judicious, delicate, sympathetic *help* for every developing scientific mind, for every wise scientific enterprise, should be the watchword.

Science is remodelling the life and thought of the world. Mere acquirement must give place to active production.

The spring is spontaneity. With this the Carnegie Institution must never interfere. Original work has ever been largely connected with teaching.

We have reached the position that, to be of the highest quality, teaching must come from a creator. What of the inverse? Is teaching a benefit to productivity? This is a vital question for the Carnegie Institution.

Sylvester held that the two functions should never be divorced.

I believe it is largely on this point that President Harper thinks the Carnegie Institution a peril.

But the great scientific work of our government has been dissociated from teaching, and on the other hand some of our well-known institutions of learning are dragging far behind the times.

For example, it seems to me that a school of science which requires Latin could not properly be given a general subsidy.

Mathematics, that general instrument and servant of all the sciences, would be chiefly helped just now by translating the results of the experts into form comprehensible to all men of science.

The mass of mathematics published in analytic and symbolic form, in hieroglyphics, is disheartening, is almost stupefying, while the great results, though capable of elegant, interesting and easy presentation, remain unknown even to men of science.

For example, of geometry Hilbert says: 'The most suggestive and notable achievement of the last century in this field is the discovery of non-Euclidean geometry.'

Then should not every man of science know what it is and what it has settled?

GEORGE BRUCE HALSTED.

AUSTIN, TEXAS.

IN answer to a request of the editor of *SCIENCE* we would suggest that a primary and natural function of the Carnegie Institution would be 'to lend a helping hand' to investigators already at work in our colleges, universities and scientific societies. This need for aid in research is more pressing than the foundation of numerous scholarships for unfledged or immature students, except for the few who

have already shown a remarkable capacity for original work.

The president and trustees of the Carnegie Institution, so far as they have yet gone, have acted wisely in appointing committees of scientific men to consider the claims for aid already received, and this seems to be the primary and most important as well as natural course to pursue.

The tendency in this country, not only in national and state governments, but also in municipal governments, as also perhaps in the management of our public libraries, is towards a marked disproportion between the cost of maintenance, and the amount, in the case of libraries, for example, devoted to the purchase of books.

It is to be hoped that at present at least the income of the Carnegie Institution will not in very large part be devoted to buildings and laboratories to be erected in Washington, but be given directly to the promotion of researches in physical and natural science now being planned or carried on by officers of existing institutions, by members of scientific societies and other investigators.

We would venture to suggest, as doubtless others have, that a fair proportion of the income should be expended in appropriations or grants, such as are made by the British and the French Associations for the Advancement of Science on such a considerable scale, and in a smaller way by the National Academy of Sciences of the United States and by the American Association for the Advancement of Science, through funds given or bequeathed by the friends of science for the furtherance of scientific investigations.

This has been effected by committees, who have and are gratuitously doing their work with care, faithfulness and discrimination.

The applications for aid in research received by the trustees of these funds from

investigators in this and other countries are already, in some cases at least, more numerous than can possibly be granted, and if we mistake not their number is annually increasing.

It seems scarcely necessary to make very exhaustive search for the exceptional genius, for already there are hundreds of investigators of fair training and ability who are more or less hampered for want of time and means to carry on and complete original work already begun.

While in physical science work has to be carried on in fixed, permanent, elaborately and expensively equipped laboratories the case is somewhat different in the natural sciences. The geologist, paleontologist and biologist need to make collections, to travel, to work in marine or fresh-water laboratories, and in laboratories for experimental evolution studies. Hence funds are needed for traveling expenses, for preparing and setting up specimens, for artists, assistants in breeding and making other experiments, for microscopic apparatus, for aid in preparing bibliographies, and in making translations of articles and memoirs in foreign languages not generally taught or studied, as Russian, etc. Finally the Carnegie Institution might lend its aid in publishing, with suitable illustrations, the results of such investigations.

These are the lines along which it appears to us this noble benefaction will accomplish the greatest results.

From the writer's point of view the pressing needs in pure, unapplied biology, and for which pecuniary help is urgently required, are the following: Further researches in the life-histories of the lowest organisms, in the growth and metamorphoses of insects, crustacea, molluscs and of the lower vertebrates, in temperature experiments in the line of the splendid researches of Dallinger, Weismann, Standfuss, Merrifield, Dixey and others, who have

wellnigh demonstrated the actual process of species, variety and race-making; in extended researches on the problems of variation, heredity, telegony, phylogeny and zoogeography. To carry out such researches as these we need much larger grants than any which have yet been possible.

To further and carry on such investigations, there is not yet needed an elaborate corps of officials and workers localized at Washington, whose climate is unfavorable for research nearly a third of the year, but the appointments of trustees or committees who shall make the grants, leaving to the investigators in all parts of this or any other country the opportunity of carrying on original scientific work.

A. S. PACKARD.

I READ with much interest the article on the above subject in *SCIENCE* of September 19. I agree with many of Professor Cattell's views, but I feel very strongly that the keynote of the activity of the Institution should be, in the words of the founder, 'To discover the exceptional man in every department of study whenever and wherever found, inside or outside of schools, and enable him to make the work for which he seems specially designed his life work.'

Whenever the directors depart from this wise policy it seems to me the step will be a backward one. The best way in my opinion to stimulate research is not to endow or build laboratories or institutions of any kind, but to endow competent men. Not elaborate apparatus is the prime necessity, but the mind to understand what is seen. The fall of an apple may suggest to a Newton a great generalization, but he needs the time and the opportunity to think and work out the law in his own way.

My idea is that men seeking endowment for research should present their

plans to the scientific society or college to which they belong, and that, on approval of the society or college, the plan of research be submitted to the trustees of the Carnegie Institution and, if approved by the trustees, a grant of money be made to be spent in any way needed by the investigator himself and at his own discretion. He can judge better than any one else how the money can be spent to advantage. The only requirement should be that he should give a detailed account of the expenditure at stated intervals, and these accounts should be open to public inspection. It may be found, however, that the most competent investigators will object to disclosing plans which they may not be able to execute and also object to the attitude of beggars.

A second plan would be for the trustees of the Carnegie fund to send statements to certain well-known colleges and scientific societies, and say that certain funds are available for research in certain departments of science, furnish us the best available man who is willing to do this work. Then give that man perfect freedom as to the how and why within the limits of the funds available for the special purpose. This would be similar to scholarship endowment which Professor Cattell recommends, except that I would not make it contingent on the attainment of any given college degree unless it be some special degree based on success in original work. Unfortunately a college degree is not a test of capacity for research. Huxley is reported to have said that he would have been floored by a civil service examination, and Darwin was not considered a brilliant student at school. The brilliant work of Faraday would have been lost to the Royal Institution if its support had only been given to doctors of philosophy.

If neither of these plans is considered feasible or sufficient, then I think the en-

dowed laboratory, observatory or institution in each department of science should be of very moderate cost and be considered merely the workshop of the investigator. This plan might be found the most feasible way of obtaining investigators because it would suggest permanency of work and arouse pride in the institution; but I wish to urge that in all cases the institution should be considered only an appendage to the investigator, and no great amount of money should be absorbed in its construction. As Dewar pointed out in his recent address before the British Association for the Advancement of Science the remarkable work of the Royal Institution of London has been carried on at a very small cost.

HENRY HELM CLAYTON.

PROFESSOR CATTELL's article in a previous number of *SCIENCE* contains many admirable suggestions as to what the Carnegie Institution might do for the advancement of science, especially where he shows the need of a fund to pay the expenses of the cooperation of this country in international undertakings of scientific character, and of more substantial aid to individual investigators than the small prizes and fellowships that are granted at present by learned societies and universities. But he seems to take for granted that the Carnegie Institution will confine itself to what is called 'science' in a narrow sense, to the exclusion of the humanities and of applications of science. This can hardly be the intention of the founder of the Institution and of its trustees. The other branches of knowledge, especially the humanities, are certainly as important for the welfare of man and as worthy of support as pure science, while they have infinitely less resources in the way of endowment of research. It seems to me that if the trustees of the Carnegie Institution intend to

give substantial and permanent aid to research in all directions, they cannot accomplish this better in any other way than by instituting bibliographical research and publication on a large scale. By endowing a Bibliographical Institute along the lines suggested by the present writer in an article in *SCIENCE* for October 18, 1901, and in an address before the American Library Association this summer, printed in their 'Papers and Proceedings,'* the trustees would in fact endow all scientific and literary research.

The bibliographical question needs a thorough solution if it shall be possible for future students and investigators to keep informed of what has been written in their lines of study. The 'International Catalogue of Scientific Literature' solves the problem for pure science only, leaving out altogether both the applied sciences and the humanities, and it does not at all touch the literature of past centuries. It is particularly unfortunate that the immense literature of the nineteenth century has been allowed so long to remain an unorganized mass. Here, it seems to me, is the greatest opportunity for the Carnegie Institution. The cost would not exceed fifty thousand dollars a year.

An entirely new institution is needed to take care of the bibliographical interests of the new century, as none of the agencies that have attempted to systematize it so far, in this country at least, will be likely to cover the field in a way that would satisfy scientific research. I may mention four such agencies, first among them the office of the *Publishers' Weekly*, from where a series of trade bibliographies have issued for more than twenty-five years. Mr. Bowker has certainly systematized this work in a very efficient way, but his office being a business house, he must of course see that his undertakings are put on a

paying basis (and bibliographical work of scientific nature can hardly ever be put on such a basis), and, furthermore, the work of his office is almost exclusively restricted to trade bibliography. The Publishing Board of the American Library Association has for years with very limited means, seconded, it is true, in a very remarkable way by Mr. George Iles, and with the partial cooperation of certain libraries, carried on effective cataloguing, indexing, and even bibliographical work, in aid of our public libraries; now, with the interest of the Carnegie endowment, the board will extend its work, but undoubtedly keep on in the lines already laid out. The interests of the Smithsonian Institution in bibliography is merely incidental, and although it has shown not a little activity in this field, it has with few exceptions stuck to the field of chemical bibliography (besides Pillings's bibliographies of Indian languages). The most hopeful agency for scientific bibliography at present is the Library of Congress, which, especially through the printed cards prepared by the catalogue division, will do excellent service to bibliography; its division of bibliography seems at present to be more or less restricted by the duties of the library to Congress, but will undoubtedly as the years go on develop its very interesting work of indexing the resources of the library more fully and more minutely than the catalogue division; but it is doubtful whether it will be able to, or even ought to go outside of the library's own collections. At least, it has been the experience of some libraries who have tried to do more extended researches in the bibliographical field, that by doing so they have encroached upon the time and the forces that were expected to be utilized in the immediate interest of those who were using the libraries. We need a separate institution, devoted exclusively to purely bibliographical work,

* See *Library Journal*, July, 1902.

and there would be no better opportunity for the Carnegie Institution to serve the whole field of science and scholarship than by establishing such an institute.

AKSEL G. S. JOSEPHSON.

THE National and State Governments are now devoting considerable amounts of money annually to scientific investigations, the results of which promise to be of direct and immediate economic value. Such investigations have been so far successful that it is now comparatively easy to secure liberal appropriations of public funds for such purposes. In our colleges and universities, the professors and their assistants are individually devoting themselves more and more to original research and are being encouraged to do this by boards of management. The funds at the disposal of these investigators are as yet comparatively limited and their amount depends very largely on the personal activity of the investigator, but there is nevertheless good reason to believe that in the future it will grow easier for such individual investigators to secure the financial backing they need to make their own investigations successful. And it seems desirable that our institutions for higher education should make the support of such research a part of their regular business, and should seek endowment for it in the same way that they seek funds to maintain their courses of instruction.

Leaving out of account, then, economic investigations supported by public funds and such relatively limited researches as can be conducted by individuals connected with colleges and universities, there remains a class of large and fundamental investigations which require special endowment. With the development of science in modern times it is clear that many fundamental problems cannot be satisfactorily studied except by the cooperation of scientists trained in different lines, the use of

complicated and costly apparatus, and investigations conducted for a long time and on a large scale. Take, for example, the fundamental problems in biology regarding the origin of life, or the principles underlying the breeding and nutrition of animals. Our agricultural experiment stations can easily secure funds for breeding and feeding experiments which seem likely to promise results of immediate practical value, and they are now engaged in making numerous such experiments, but it has been difficult for them to devote even a small portion of their funds to the more fundamental studies of breeding and nutrition. Wherever they have ventured to attempt these, the work has as a rule been on too small a scale to give the best results. Instead of the few hundred dollars spent annually in such researches, it should be thousands of dollars; instead of experiments with a few subjects, there should be experiments with a considerable number of subjects in order that general rather than special conclusions may be drawn from the work.

For example, the most elaborate investigations on the nutrition of man yet conducted are those of Atwater with a respiration calorimeter, in which a single subject was studied during periods of three to twelve days. While the results of these investigations have been valuable, they are from the nature of the case not thoroughly satisfactory. Not only should the apparatus and methods for such investigations be further improved, but there should be opportunity for carrying them on with a number of calorimeters at the same time and for longer periods. This would necessitate the expenditure of relatively large sums of money in this kind of research, but it would be money well spent, for there would be a much larger chance of securing some definite and final results than present conditions of research in that line afford.

As regards the breeding of animals, almost all the work thus far done by the experiment stations has been empirical in character. There is at present no satisfactory manual on the breeding of animals written from a scientific standpoint, and I am informed that the data for such a treatise are not available. To make a thorough study of the science of animal breeding would require the maintenance of considerable numbers of animals and studies continuing over many years.

I have cited nutrition and animal breeding as among the subjects on which elaborate and costly scientific investigations are needed, because I happen to be somewhat familiar with the nature of investigations in these lines. There are of course many other lines in which similar investigations are equally needed.

From what I have said it is plain that, as regards the Carnegie Institution, I am in favor of the expenditure of its income in relatively large blocks for the maintenance of elaborate investigations on a limited number of fundamental problems of science, and especially those fundamental problems on the solution of which largely depends the improvement of the conditions of human life, industry and society.

A. C. TRUE.

It would be presumptuous for any one to suppose that he has solved the difficult problem that is before the trustees of the Carnegie Institution. They are to be commended for the free expression of opinion they have invited, and doubtless the policy they adopt will represent a fair resultant of the varying competent opinions of American men of science. In any discussion of a general policy one cannot deal with details except by way of illustration, and illustrations are taken most naturally from one's own department of work.

I have taken for granted that the pur-

pose of the Carnegie fund is to increase the opportunities for scientific research, so that the results may be more commensurate with the number and ability of investigators. This means that it is to supplement the efforts made by existing institutions, which in the main are the government scientific bureaus and the universities. To duplicate what these institutions are already equipped to do would seem to be a waste of this particular fund. There is probably no diversity of opinion in reference to this proposition, and the real problem is to discover wise methods of supplementing the opportunities for research.

My own constant thought has been that no single costly enterprise should be undertaken at first which might pledge permanently a large amount of the income, and might prove presently to be either unprofitable or too narrow. For example, the expenditure involved in the purchase and development of the Marine Biological Laboratory at Woods Hole would certainly lock up all the funds available for biology, and this would be a narrow view to take of the opportunities needed for biological research. Speaking for my own subject, fundamental as are the problems that must be investigated in a marine laboratory, there are botanical investigations of equal importance that must be made over the general surface of the country. It has seemed to me, therefore, that the first experiment to be conducted by means of the Carnegie fund is to discover how it may be expended so as to yield the largest results. As laboratory students we know that no amount of discussion will result in this discovery, but that trials must be made before 'the trail is struck.' This means the absence of any detailed and rigid policy at present, but one of such great flexibility that retreat is possible at every point.

To make this endowment perennially

effective and free to be applied as the needs of scientific research develop, it would seem wise to stimulate every worthy enterprise to self-support as rapidly as possible, and to help it no longer than it needs help to be effective. I am sure that a good deal that is undertaken can be gradually unloaded upon universities, state and national governments, or even upon other private endowments, leaving the Carnegie fund free to turn to the new fields that need cultivation.

In my own mind there are at least three categories in which the needs of increased opportunities for scientific research may fall, and these suggest methods of supplementing the opportunities offered by existing establishments. Other departments of work may have different needs, but I am speaking under the pressure of the needs of my own subject.

1. There are competent investigators, whose ability is well known, who need in the main more leisure for work, and in some cases perhaps more equipment. Anything that will meet this need is sure of results. Just how these investigators can be selected, and how their needs may be met without any relaxation of effort on the part of the institutions to which they belong are matters of detail. From such men no outline of work or promise of results can be exacted, for it is the unexpected that often leads to their most important discoveries. Perhaps in this same general category may be placed the needs of those who give promise of becoming competent investigators, but to whom lack of means has denied the opportunity for advanced training. This opens up the whole question of fellowships, and it may be urged that this is the business of the universities. It is a notorious fact, however, that not one-fourth of the promising candidates that apply for fellowships can obtain them.

2. There are well-defined general prob-

lems that need a corps of investigators to collect data, which no existing institution is likely to provide for. Speaking in the largest sense, competent and prolonged biological surveys of various kinds, over various areas, are sadly needed to reduce our loose empirical statements to definite statements of facts. Such work can be definitely outlined in scope and purpose, and the results are assured.

3. Students of botany have no greater need at present than a good station in the American tropics, where tropical material and conditions are available. The highest and most varied expression of plant life is found in the rainy tropics, and the laboratories of temperate regions are only on the border-land of their subject. To establish such a laboratory and to make it possible in the way of transportation for competent investigators to visit it when their problems demand would be one of the greatest opportunities that could be offered to American botany. The important results that have been obtained in the Dutch station at Buitenzorg, Java, visited by comparatively few investigators, prove what an American station, near at hand and inexpensive to reach, would do for botany. It is probable that in the establishment of government stations in the tropics for practical purposes such cooperation could be arranged that the only need would be a modest equipment and reduced transportation.

Even if such a general outline were adopted, the most effective selection and methods would have to be discovered through trial.

Of course, in all sciences facilities for starting new work would be desirable, but the greatest present need in botany is to make it possible to do in a better way and upon a larger scale what we already have in hand.

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