Gulf of Mexico for the first time communicated freely with the Pacific Ocean through the Tehuantepec portal. After middle Pliocene time this portal also was closed, and the whole of Central America has remained ever since an emergent and rising area. The Bermudas were submerged for at least a part of Pliocene time.

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THE BIOLOGICAL ARTICLE AND THE OBLIGATIONS OF ITS AUTHOR[1]

AN address on an occasion like this gives one an opportunity to present some phase of current work that he deems of general interest or to discuss questions of concern to the group. Most of us would be inclined to agree that it is much more interesting to find out new facts and to discuss them with others than it is to give attention to questions of writing or publication. Having but recently lifted my head above an accumulated mass of manuscripts, the impression is strong in my mind of the evident weaknesses in our methods of publication and of the possibilities for improvement. The problem of methods of communication between investigators has existed since the beginning of scientific work. Merely as a matter of record, one writing is possibly sufficient, but to spread information of discoveries most profitably requires multiple copies. It was easy in the time of Leeuwenhoeck for him to sit down and indite a letter to the Royal Society describing his discovery of the new organisms in infusions and his delight and wonder in them. A natural forward step from this was for organizations to commit to the printed page a record of the discoveries of their members. In fact, all our means of communication are the result of these spontaneous responses to the necessities of the moment. We accordingly have organs of societies which represent the efforts of a limited group; we have journals which have been established through the energy and enterprise of individuals; there are the publications of research institutions which have been developed in response to their needs for recording and disseminating results of their studies and, finally, there are those journals which have been established by commercial houses which have, either through interest in scientific work or through a belief in the value of advertising, seen the advantage of attaching their names to serials.

Science is so new and of so rapid a development that its procedures are still largely empirical and only roughly adapted to the present scope and complexity of the field. This is particularly true of our publications. Some have a long and honorable history, largely because of fortunate connections. Many have lapses and others have changed relations or subject-matter and so have survived. Most of our old journals are those having scientific connections either with incorporated societies or institutes, or those with business associations. All these experiences are natural under the circumstances and present valuable suggestions for future conduct if carefully studied. As scientists we should feel the challenge to take stock of these experiences and to devise means for getting our communications shaped to modern requirements and for providing an effective and convenient system of journals to meet the needs of all groups of biologists and all aspects of the subject.

The fundamental question which we have to consider is: Are publications incidental in their relations to biological progress and so to be left unconsidered, or are they essential elements of the program and deserving of careful planning and management? In the developmental stage of our subject it was natural that progress should be tentative and without comprehensive plans. In its present state, has not the time arrived for careful study and planning? Here we have to consider whether anything else can be done to improve the service of our journals without sacrificing the essential freedom of investigators to work in the manner best adapted to produce results.

If we hope to improve the character of scientific papers it is imperative that we give thought at the same time to where they are to appear, for the character of the article depends in part at least upon the medium available for its publication. The problem then is to discover the course which will make most easy and profitable the use of written records of our discoveries and which will run the least risk of smothering individual initiative and opportunity.

As a necessary preliminary to any future action we must stop to consider our present situation. In doing this we find that there are usually produced about 40,000 titles annually, scattered through some seven or eight thousand periodicals and filling perhaps 500,000 pages. The consideration suggests itself that while this is a staggering total, there are represented a great variety of subjects, so that the individual worker with limited interests is not necessarily concerned with the whole output. While this is certainly true it is also evident that with a growing output there inevitably follows increasing personal limitation of contacts, because each of us has but a limited time to give to reading, and the more that is employed in searching the less there remains for actual reading. While the subject itself is rapidly broadening and ex-

[1] Address delivered before Section F—Zoology, of the American Association for the Advancement of Science, New York, N. Y., Friday evening, December 28, 1928.

tending its scope, the individual becomes increasingly narrower and more specialized.

To older workers who have grown up in the subject or to those who have not been obliged through experience to consider the problem in its entirety, the intensity and growing seriousness of the problem is not so evident. The exceptionally placed or fortunately endowed person can still maintain his connection with his field, but the beginner and those less fortunate are in distress. Looking also beyond the present and considering our responsibilities towards those who follow us, we have other reasons for giving serious thought to the nature of our written work.

A review of the journals that now serve us indicates that they have some definite limitations. They are often not definitely representative of the subjects indicated in their titles. They overlap the field of other journals on one hand and neglect phases of work still uncared for. Taken altogether they do not cover the whole field. Some subjects are provided with many outlets; others with few or none. In management they tend to be irresponsible and sometimes inefficient. Generally they are inadequately supported, which sometimes results in their early extinction. Doubtless in many cases this is an advantage, but may result in serious inconvenience to those served. The quality of the make-up and illustrations inclines to be poor. If the price is low enough for individual workers to subscribe, the quality is indifferent and the life of the publication short. When, on the contrary, the journal is in the hands of a publishing house which desires to make it profitable, the price is so high that the individual worker can not afford to possess it. In few cases do our journals conform to the ideals of what a scientific journal should be.

When we turn to the consideration of the articles which appear in these journals, many of us would be inclined to agree that they possess some or all of the following defects:

(1) The author takes a wrong attitude in writing, so that frequently this is highly subjective and indicates most clearly that the facts and impressions have been set down by the author, not with the idea of informing his fellow workers of the nature of his observations and conclusions, but rather as a record of his own impressions. I have the conviction from much practical experience that if our investigators would give primary consideration to the needs of their readers a very great reduction in the volume of literature would result. Very frequently in an editorial capacity I have found it possible to persuade authors to reduce the length of their articles as much as 50 per cent. merely by suggesting that they be written for the reader rather than for the writer.

(2) When we compare biological articles with those written by chemists and physicists we are impressed by the evident verbosity in style and redundancy of detail observable in biological papers. Frequently there is over-much historical survey and a multiplicity of quoted opinions which are entirely unnecessary for clear exposition. Excessive and expensive tabular data of interest to only a limited few also encumber many articles. Repetitions of already available bibliographies and the inclusion of unnecessary illustrations are not uncommon faults. Mere repetition of facts with unessential differences in detail from those recorded in previous publications multiplies many pages.

In considering possible improvements it is recognized as indisputable that there should be opportunity for investigators to publish whatever views they may have, that there should be no compulsion to adopt any particular form or attitude in treatment of their results, and that agreements of majorities should not be allowed to cripple the ambition or initiative of individuals. However, we must recognize that complete anarchy is neither possible nor desirable and that restrictions are inevitable and necessary. Such restrictions are, however, best imposed according to the judgment of representative opinion rather than according to individual whim. It is inevitable that under any circumstances the opinion of leaders will have disproportionate weight. In considering the rights and privileges of authors it should always be remembered that there is an essential difference between freedom to work without restriction and freedom to publish *ad libitum*.

Also to place limitations upon articles submitted to journals having definite objectives is not to close all opportunities for publication. The policy of restrictions in journals is one long established. The mere fact that a particular field is chosen limits the range of included articles, and to designate, in general terms, their form and extent is only a slight step further. At some point or other the needs or desires of the individual are sure to conflict with the interests of his group. When this point is reached the one must of necessity give way to the many. There is undoubtedly an educational value for young investigators in the writing up of their investigations and it is held by some to be a function of our journals to supply this training. It may well be doubted, however, whether it is the obligation of the editor, already overwhelmed by his own duties, to contribute thus to the operations of others. Rather it should be the obligation of those in charge of laboratories to see that articles coming from them should be expressed in dignified, effective and understandable language. It is no more appropriate to put the responsibility for judging the form and character of an article upon the shoulders of an editor than it is to hold him accountable for the character of the work described.

Very properly he should be asked to judge the availability of the paper for his journal and to prescribe its length according to ready funds, but he should not be required to assist in its production.

The author does not stand alone. It is recognized that to a large and increasing degree investigators are becoming mutually interdependent and that with the increase of such interdependence the responsibility of the individual to his fellows is correspondingly augmented. This implies that, in the nature of the case, restrictions, self-imposed or by external compulsion, must result. While practically unrestricted publication through separate brochures and books is possible, the introduction of an article into the journal of a society may come only through conforming to certain general tenets and rules, often ill-defined, but generally recognized. Unfortunately the cost of publication sometimes imposes additional restrictions not always desirable in character.

In view of this evident mutual dependence of investigators, it might well become the author to inquire rather closely on two points. If he contemplates making a permanent addition to the literature on any subject which will in the course of time be consulted by many other workers and repeatedly referred to in bibliographies, it is only just that he should seriously consider whether he has anything in the way of new facts or pertinent generalizations to add to our knowledge of the subject. It is probably all too true, as is frequently urged, that there has been undue pressure brought to bear, especially upon young investigators, to publish in order that they might bring their names before the scientific public. As a corrective measure some have even gone so far as to suggest the organization of societies for the prevention of publication, but I think we would all agree that this is extreme. Even the mildest of us would, however, be inclined to agree that the author owes it to his fellows to consider carefully the value of what he proposes to contribute. If, after this self-searching, he still feels that his contribution may be worthy, he has next to consider how it should be presented so as most readily and fully to serve the largest number of interested workers. Certainly it is a truism to say that neither the number nor the length of articles should be the measure of service, but rather the quality of the results and the form of their presentation.

In the search for light upon the character and form of his contribution the author certainly should feel that those with whom he is immediately associated have some interest in what he proposes to do, and in most well-regulated departments he should feel free and even impelled to get the judgment of his fellows. It is not easy for one to be assured of the value of his own production and it is often an invaluable help to have some one intimately associated with him to pass judgment upon his work.

When the author has done his best in these ways and has the article ready for presentation, the responsibility as to its future disposition often devolves upon the organization which supports the journal in which it is proposed to publish. Obviously such an organization or its representatives must judge whether the type of article is appropriate to the journal and may even go further and ascertain whether it is in the form which would make it a most worthy contribution. As the matter now stands, in many instances the group representative must proceed even further and judge the quality of the article or even its literary form. The appearance of an article in a journal sponsored by a society would imply that it does not do violence to the current opinion of the group, but would to that general degree carry with it the support of the group. For this reason the organization is entirely justified in exercising such a measure of censorship as will insure a reasonable conformation to accepted views.

In considering possible needs in our publication situation I do not desire to indicate in detail what should be the character of biological articles or what the attitude of author or authors or the responsibility of the organization involved, but rather to suggest how this may be determined and defined. In approaching this aspect of our subject I am forcibly reminded of the opinion of Matthew Arnold expressed in his "Essays in Criticism," when he considered the possibility of establishing in England an academy similar to the French Academy. He says:

> Such an effort to set up a recognized authority imposing on us a high standard in matters of intellect and taste, has many enemies in human nature. We all of us like to go our own way and not be forced out of the atmosphere of the commonplace habitual to most of us. We like to be suffered to lie comfortably in the old straw of our habits, especially our intellectual habits, even though the straw may not be very fine and clean.

There are so many things to be considered when we approach a problem of this character. In most cases we wish to be assured in some manner or other that the substance of the article is worthy of record, but there are those amongst us, blithe spirits who play with words in so pleasing a manner that we read what they have to say not for what it means primarily but simply for the pleasure we find in the manner of expression, and we would not wish to deprive ourselves of such pleasure by any rigid determinism.

If we desired only the immediate improvement of our scientific output, possibly the best way would be

to provide a benevolent despotism consisting of the best editors we could find and placing entire responsibility in their hands. But if we are concerned with the eventual and permanent improvement of our product, we would doubtless find here, as in other cases of absolutism, that the effort for immediate improvement results in eventual decadence. We have to look towards the future and the development and improvement of the coming generation. We would therefore feel safer in adopting such measures as will insure general study and thought by as many of the human element as may be drawn into such consideration. It is education and not compulsion that we would best choose.

We have here occasion to consider again the two aspects of the program: (1) to develop in the mind of investigators through discussion and personal consideration a working conception of what should be the form and content of a biological paper of a particular type; and (2) through organization to plan a system of publications which shall care for all phases of work in the field, and shall care for different types of writing—original articles, reviews, abstracts, etc.—and indicate the best form for each of these.

As to the means for effecting improvements in articles, I imagine each one of us would have his own opinions. After giving the subject much thought it seems to me that at least one practical way of proceeding would be somewhat as follows: First, to secure the interest and attention of those most familiar with the problem; second, to spread the consideration of publication questions by involving numbers of workers in different organizations through committees appointed by societies to study them; third, to develop these opinions further by bringing together representatives in various groups for comparison of views; fourth, after some consensus of opinion has been reached, to formulate a general statement regarding the form and character of biological articles which might serve as a guide, but not a rule, for others; fifth, to submit such a statement to responsible organizations for criticism and consideration; and, sixth, perhaps finally to publish the statement as a majority opinion which might be used in a variety of ways.

In outlining the question of improving the character of our journals we might undertake careful studies to discover first, the various types of publications required; second, to find the best means of conducting and managing these; and, third, to obtain an appreciation of the relative responsibilities of the author, school or department, society and other organization involved. Any program decided upon should recognize that our situation is not static, but that it often changes rapidly so that any program of improvement should be flexible. Also in view of the established position of existing journals, the application of any program of improvement should be gradual, taking advantage of opportunities and allowing fully for the work of individuals who have had the energy and foresight to provide means of record and communication for others.

When we attempt to go into the question of determining the precise function of a biological article, at first sight it might seem easy, but careful consideration reveals that such articles may do many things. Among these obviously they supply a permanent record of new facts. They reveal the investigator's interpretations of these facts. They at the same time serve to clarify and unify the author's views. They also explain the methods by which results were obtained, and to the discriminating reveal the author's aims and attitude. In the case of beginners they afford training in methods of exposition. Among these possibilities may occur conflict between the welfare of the author and that of his readers. In most cases it would seem quite right and proper that the good of the many should transcend that of the one. We must recall here again the weighty fact that there are many who come after us, and, considering all contrasting claims, the case of the many as opposed to the one grows in importance with the years.

There are those who consider the rights of the author paramount, the claim being that the results of an investigation belong to the author and are his to dispose of, but this is not entirely true, for he owes his opportunities in most cases to institutions which pay him for his time, provide him with facilities for work and are judged by its quality in relation to similar work from other institutions. He is largely indebted also to his fellow workers who have in the first place introduced him to the subject, trained him in its methods and provided him with the background against which he works. But, even assuming that the author is a creator of values that, *ipso facto*, adhere to him, he automatically relinquishes his exclusive rights when he passes his results on to his fellows by publication. He must consider how his contribution should be built into the common edifice, and he can not demand that he be allowed to dispose of it regardless of the established plan. In attempting to evaluate the various functions of an article we must consider how they stand in relative importance and, in the event of sacrifice, determine which should go first. If the apparent rights of the author come into conflict with those of his fellows, and he be willing

to cast aside the restraints of group purpose, as conceivably he might be justified in doing, he always has the recourse of independent publication. This will insure him a hearing without involving others in responsibility for his views.

Second-hand book shops carry as dead stock on their shelves many appeals from decisions adverse to accepted tenets. In these times it would be an exceedingly rare occurrence for a major injustice to be done in this way.

If an editor, from painful experience, be permitted to suggest some detailed matters in which our biological articles might be improved, I may mention several.

There is the general form of treatment which any particular article should have. The growing conviction that commonly this takes the subjective rather than the objective obtrudes itself. A comparison between an average run of biological articles and a similar series in the physical sciences strongly confirms this suspicion. Undoubtedly clarity of presentation and definiteness and serviceability of the facts presented would be suggested if a plain and simple statement of the facts involved were made. We have to consider here not the mere question of brevity, but serviceability. Brevity may be the soul of wit, but it is not always the best form in which to embody an idea. Papers should be long enough to present clearly the situation described, but no longer. Brevity is not an end in itself, but only a means to greater precision of statement and convenience of use.

The oft-repeated criticism of the style of English found in scientific articles may trace back to faulty analysis and planning rather than to misuse of words or constructions. We may not be justified in demanding that the articles we read be entertaining, but at least we can ask that they be clearly informative.

Perhaps it is too far a cry to enter into the question of the author's attitude, and fortunately this is not so much required as might formerly have been the case, but one is tempted to express the opinion again that matters of priority and personal credit are not our primary concern, but rather the advancement of the science in which we choose to labor.

We might also wish, speaking editorially, that authors would give more thought to the type and the number of illustrations which they utilize. Not infrequently it is asked that we draw strongly on our limited funds for the purpose of repeating uselessly the same type of figure with minor variations, whereas one clear example would be entirely sufficient. It seems not to be fully realized that illustrations are the author's interpretations and that mere repetition of the same conditions will not add to the objectivity of the fact.

After wading through repeated historical surveys of the same topic in a series of papers, one is tempted to wish that this phase of presentation might suffer an eclipse. Undoubtedly there is need for this critical treatment of accumulated facts, but there ought to be provision for such in a type of publication devoted exclusively to it. Similarly, the constant repetition of the same material in bibliographies leads to the suggestion that reference to existing comprehensive bibliographies might often take the place of these repetitions. It would be an added convenience if there were some reasonable standard in the form that references should take.

These are only a few of the many features of editorial work which are the constant experience of those who have been drafted to function in this capacity. Should one wish to go further than mere palliative measures and indulge in Utopian dreams of what might best be done for our ultimate benefit, there is suggested the comprehensive plan by group action of a system of journals in which there would be provision for covering the biological field by journals with definite limitations of scope and treatment. As it is now, the same general subject, such as cytology or genetics, may be found represented in a large number and variety of journals so that it is beyond the possibility of an individual investigator to possess the serial literature in any subject, and it is growing to be the case that even libraries are embarrassed by the number of journals and the distribution of articles within them. It would be of greatest value if our materials could be definitely segregated according to the needs of existing groups. This would greatly facilitate the matter of reference and would even make possible individual possession of the main sources of information. We need also a selection of materials according to the treatment accorded them. We should have journals in which brief articles within a fairly limited field might be found. There should be other journals where longer original articles might find a place. Also there should be publications of a monographic type which are expensive in production and limited in distribution. We need also reviews of various types and that more highly developed and difficult type of treatment which involves the critical faculty in a large measure.

The growing need for a ready and brief introduction to the literature through abstracting systems has progressed further with us and has found measurable realization. So far, such progress as we have made in perfecting our publication facilities has been of an uncertain and incidental character. It does not seem that we can hope for great progress until we have made this feature of our work a major problem and have given it some such degree of consideration as is

involved in measures required to secure the facts which are to be recorded.

Any one with experience in biological publications must realize the complexity and difficulty involved and so would hesitate to suggest a definite remedial plan. Certainly I have no intention of presenting one. What I would plead for is a sustained, careful study of the problem with the gradual introduction of such features as from time to time justify themselves. Our societies are not by nature well adapted to the execution of concrete projects, but for the study of such questions as the means of making most available and useful the common store of knowledge in a subject it seems to me they are peculiarly suited. Is it too much to hope that our biological organization may meet constructively what, to many of us, seems to be an approaching crisis in a major department of our activities?

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HENRY BURCHARD FINE

IT is with profound regret and a sense of the loss which has been sustained by the academic world that we record the death, on December 22, 1928, of Dean Henry Burchard Fine, of Princeton. In the evening of the previous day, the bicycle which he was riding was struck by a motor car and he was thrown with such violence to the roadway that his skull was fractured. He never recovered consciousness and died early next morning. He was in his seventy-first year, but in full mental and physical vigor, and there seemed every prospect that many years of usefulness still lay ahead of him.

Fine had been connected with Princeton University either as student or teacher for over fifty years. He entered as a freshman in 1876, and at once took a leading place in his class and eventually in the undergraduate body, by the force of his intellect and the vigor of his personality. As happens so often, his first interests were not those which afterwards attracted him. In his earlier college days he was an ardent student of the classical languages, and when he took up the study of Sanskrit the career of a philologian seemed marked out for him. Later in his course, however, largely owing to the influence of George Bruce Halsted, who had a very stimulating effect on the men who came in contact with him, he was attracted to the exact logic of mathematics. After a graduate year spent as fellow in physics, he was appointed an instructor in mathematics. He spent a year and a half, on leave of absence, in Leipzig, working under Felix Klein, and there took his doctor's degree in 1885, with a thesis on a subject connected with Grassmann's "Ausdehnungslehre." His interest in the foundations of mathematics, which was heightened by this investigation, bore fruit a few years later in the publication of his "Number System of Algebra," a little book which was perhaps not suited to the general run of elementary students, but was extremely fascinating to those who were interested in abstract thinking. The same accuracy of logic and the same instinct for perfection of statement appear in the two text-books on algebra and the calculus, which were published later in his career, the last one in fact appearing only the year before his death. In 1891 Fine was appointed to the Dod professorship of mathematics, and from that time on his position as leader of the mathematical department in Princeton was recognized. It was his settled policy to introduce into that department only men of proved abilities in research, and under his guidance the department has been continually strengthened and its productivity increased. Whatever reputation Princeton now has as a center of mathematical activity is due largely to his firmness of purpose and his wisdom in the choice of men.

Fine was a member of the American Mathematical Society from its foundation, and for a term served as its president. He was also a member of the American Philosophical Society.

As an administrator Fine rendered great service to his university. In 1903, early in the presidency of Woodrow Wilson, he became dean of the faculty, with charge of the scholarship and discipline of the undergraduates. He introduced the policy of establishing fixed rules governing the standards of scholarship, which were generally recognized as reasonable, and of enforcing these rules rigorously and almost automatically. This policy has been followed ever since with good effect. From time to time, as the opportunity offered itself, the standards have been raised, but the method of administering them has remained unaltered. Fine's impartiality and his sympathy with other men's points of view contributed to his success in the establishment and development of his policy.

In 1909 Fine was given by President Wilson the task of supervising the development of the school of engineering, and the organization of the various scientific departments, with the title of dean of the scientific departments. He retained this position when he resigned the deanship of the faculty, and by his initiative and helpful advice he was largely instrumental in the development which those departments have had in recent years. He had an important part in the negotiations with the General Education Board which resulted in the gift to Princeton University from the board of one million dollars for the endowment of research in science, and the additional two million