no other undertaking of such importance as *Biological Abstracts* is attracting the attention of American biologists. There was, however, no disposition to shift responsibility for the *Abstracts* to some other organization. The conviction of the executive committee that the Union "must be preserved," at least until *Biological Abstracts* is permanently financed, and that other activities may wait upon future demands seemed to be that of the conference.

As the original financing of the Union is about exhausted, the conference discussed methods of raising money for advertising within the member-societies and otherwise promoting the interests of *Biological Abstracts*. The matter was referred to the executive committee for further discussion with officers of the societies. This advertising looks toward an increase in the subscription list of the *Abstracts*. Such an increase must occur if we expect to convince those who can provide for editorial costs that *Biological Abstracts* has the unquestionable support of biologists, not only in America, but in other countries, since it is an international enterprise.

BIOLOGICAL ABSTRACTS

By Dr. J. R. SCHRAMM
EDITOR-IN-CHIEF

ABOUT May 1, 1931, the funds in the original grant from the Rockefeller Foundation for the editorial conduct of *Biological Abstracts* will have been exhausted. Very recently (December 1 of last year) a continuing grant for two years was made by the Foundation. The present therefore marks the approximate close of the preliminary chapter in the development of *Biological Abstracts,* and it is thus appropriate that a report be made on the status of the undertaking. It will be well at the outset to outline the facts upon which the project was predicated.

Biological articles of a research character number at present over 50,000 a year. They are published in some 6,000 serials and in over twenty-five languages. They cover annually hundreds of thousands of pages, and cost millions of dollars a year to publish.

There exists no system of distribution of manuscripts by subjects to specific research journals. Even were such a plan devised it would soon be rendered ineffective by the rapidly changing character of the subject.

The necessity under these circumstances of instruments of orientation in the literature is obvious. With the phenomenal growth of the literature in biology, especially in this century, these have increasingly taken the form of abstracting journals in more or less highly specialized fields and are rendering great service.

Increasing specialization has brought with it, however, a corresponding insistent problem of synthesis; wholes have to be constructed from larger and larger numbers of smaller and smaller parts. For this purpose the highly specialized abstracting journal is less well adapted, for important progress in one field frequently springs from advances or suggestions from another, even a remote one, resulting in the intimate linking of fields considered relatively unrelated. Also, between highly specialized abstracting journals extensive duplication is unavoidable.

Among striking examples of such integration may be mentioned: genetics and cytology, and between these subjects and systematics; plant and animal pathology and parasitology on the one hand, and entomology on the other, especially through the rôle of insects as pathogen vectors; cytology on the one hand, plant and animal pathology on the other; public health administration and systematics of disease vectors, *e.g.,* fleas, mosquitoes, etc.; economic entomology and plant ecology; protozoology and pathology; anatomy and physiology; serology, biochemistry and biophysics on the one hand, phylogeny on the other; bacteriology and plant pathology; systematics of poisonous animals and serum therapy, etc., etc.

Such changes, often abrupt, are largely unpredictable and frequently lead to marked changes in emphasis and give new direction to research endeavor. These developments are indicative of an increasing integration in which the various biological disciplines, not infrequently characterized by more or less isolation and lack of mutual understanding, are converging and each making substantial contributions to common problems.

Also, there is a growing realization that applied fields prosper best when firmly rooted in the more theoretical disciplines underlying them. That this association is fruitful to the theoretical fields as well is evident in the wealth of suggestions and problems contributed and in the vigorous personnel recruited.

The problem has its important economic aspects. Under a system of numerous specialized abstracting journals, it is not uncommon to find institutions expending annually from $300 to $800 and more on abstracting journals in biological subjects, though leaving considerable fields almost untouched. Prices of individual specialized journals have reached a

point in most cases entirely beyond the reach of individuals, annual subscription rates with few exceptions ranging from twenty-five to seventy-five dollars and more. In contrast to this state of affairs is the situation in chemistry, where admirable single comprehensive services, *e.g., Chemical Abstracts,* are available at a small fraction of the cost for comparable services in biology, thus keeping such instruments within the reach not only of institutions but of individuals as well.

How, then, are the workers in the diversified but increasingly interdependent science of biology to be kept in contact with the literature to best serve its immediate and changing needs and to provide the most favorable conditions for its sound growth?

Dr. McClung has summarized the study of this problem by the Joint Publications Committee of the Union, the Division of Biology and Agriculture of the National Research Council, and the American Association for the Advancement of Science, which resulted in the recommendation to establish a single comprehensive abstracting journal for theoretical and applied biology exclusive of clinical medicine. Besides this basic recommendation, the report of the Joint Publications Committee contained the following major items, based upon the literature of 1921 and conditions as existing in 1922–1923:

1. Number of titles annually in theoretical and applied biology exclusive of clinical medicine, approximately 40,000.
2. Number of pages required to cover this literature (40,000 titles) in one or more abstracting journals (assuming that there were no duplications) on the basis that 6.8 titles could be cared for per page, about 6,000.
3. Cost of manufacture of 6,000 pages of abstracts plus 500 pages of indexes (estimated) in an edition of 7,000, $58,000.
4. Subscriptions:
   a. It was estimated that 1,000 subscriptions could be secured to such a comprehensive journal at $15.00 annually—$15,000.
   b. This leaves $43,000 to be carried by individual subscriptions and advertising. Should each member (total 6,000) of the societies adhering to the Union eventually support the journal, as the members of the American Chemical Society support *Chemical Abstracts* through their society dues, the cost to the individual would be $7.16 (assuming that all editorial overhead were met in other ways).
5. Editorial cost of caring for 40,000 papers annually on a non-honorarium basis, $75,000.

This report was adopted by the Union and by the Division of Biology and Agriculture of the National Research Council, with authorization to seek funds for putting the recommendations into effect.

Although the report was the result of a long study and had the approval of both the Union and the National Research Council, it was submitted to biologists individually in a general referendum, receiving a favorable vote by from 83 to 97 per cent. of the voting membership of the twenty-odd member societies of the Union.

With this mandate, and after extensive discussions with European biologists, the Union, with the active cooperation of the National Research Council, sought and secured funds for the editorial conduct of the abstracting service, the cost of printing and business management to be defrayed out of subscription, advertising and other income. In November, 1924, $350,000 was made available by the Rockefeller Foundation over a period of ten years, not to exceed $50,000 to be expended in any one year. The National Research Council has acted as repository for the current funds, and has disbursed them on requisitions and vouchers approved by the editor-in-chief of *Biological Abstracts,* the president of the board of trustees of *Biological Abstracts,* and the chairman of the Division of Biology and Agriculture of the National Research Council. There are thus on file in the office of the treasurer of the National Research Council the complete official audited accounts representing the expenditure to date. The record of expenditures given below is therefore limited to the total annual amounts in the several budgetary items.

It is to be noted that the sum estimated by the Joint Publications Committee as necessary for the editorial conduct of *Biological Abstracts* on the basis of an annual literature of 40,000 titles abstracted without honorarium was $75,000; the maximum sum available under the grant was $50,000 annually. That the latter sum would prove inadequate under even extremely economical procedure was clearly foreseen, as the committee's estimate was based on a knowledge of costs in a number of current abstracting services. However, it was decided to go as far as the resources permitted, hoping that some adjustment could be effected. Active operation was begun in 1926, and in December of that year the first number of *Biological Abstracts* was issued.

The project has been organized primarily as a scientific one and on an essentially cosmopolitan basis. Though under American management, the journal is non-provincial in production. In the main the cooperation is from individuals, representing every country with research biological activity; in some cases more formal arrangements have been made. To date over 100,000 abstracts have been published. A fair operating experience has thus been accumulated and in this light it is proposed to review the estimates and conclusions of the Joint Publications Committee in 1923.

EXPENDITURES 1925–30, EXCLUSIVE OF PRINTING AND BUSINESS MANAGEMENT

Year	Salaries	Supplies	Equipment	Travel	Total
1925					$ 19,761.97*
1926	$ 34,957.55	$2,947.63	$ 3,518.70	$ 352.05	41,775.93
1927	45,196.29	3,469.41	875.55	512.74	50,053.99
1928	52,405.12	4,474.32	1,138.17	347.27	58,364.88
1929	67,153.59	3,579.05	720.42	328.34	71,781.40
1930	70,991.38	3,766.81	836.48	879.77	76,474.44
Totals	$270,703.93	$18,237.22	$ 7,089.32	$ 2,420.17	$318,212.61

* Of this sum, $10,000 was allocated to *Abstracts of Bacteriology* and *Botanical Abstracts* to complete editorial work to January 1, 1926, both journals having voted to merge into *Biological Abstracts;* the remainder was used for preliminary organization of *Biological Abstracts.*

(a) *Size of the literature:* While a final and highly authoritative statement can not yet be made on account of uncertainty regarding the literature in certain countries and existence of a known group of serials not yet covered, biological literature as circumscribed in *Biological Abstracts* will total about 55,000 titles in 1931; the committee's estimate on the basis of the 1921 literature was 40,000. The difference is due primarily to three causes; (1) Marked increase in published research since 1921; the encouragement given to biological research in recent years by increased provision of fellowships, etc., is an important factor here. (2) The increasing tendency to publish brief preliminary and progress papers; here should be mentioned also the marked post-war increase in national and international congresses, the proceedings of which add in some years several thousand titles. (3) Underestimates by the committee due to inadequate knowledge of the literature in certain fields.

(b) *Size of a comprehensive abstracting journal for biology:* Adjusting the committee's estimates to the typography and format adopted for *Biological Abstracts,* a page would accommodate twelve abstracts; the average to date is 10.6. It is safe to restate the committee's estimate that the journal for years to come will not occupy more than six inches of shelf room per year. The space economy is the result of a careful study of papers, typography and format.

(c) *Cost of printing:* Actual costs are slightly under the estimates of the committee.

(d) *Subscribers:* The committee estimated that 1,000 institutional subscribers at $15.00 annually could be secured. The number at present exceeds this expectation by several hundred. The committee made no estimate of the number of individual subscriptions that might be secured on a voluntary basis. Little effort has been made to secure subscriptions among individuals pending the more complete development of the journal and the appearance of the indexes. However, about 1,300 are in hand and sustained efforts to increase this number are about to begin.

(e) *Editorial costs:* The editors planned and are operating the organization with the following major items of economy:

(1) *Cooperation from libraries:* To subscribe to, or to exchange for, the approximately 6,000 serials which require perusal for *Biological Abstracts* would, conservatively, cost $30,000 annually. Through courtesies and cooperation generously extended by certain great libraries, notably those of the Academy of Natural Sciences of Philadelphia, the College of Physicians of Philadelphia, and the U. S. Department of Agriculture, this prohibitive expense has been avoided.

(2) *Editorial offices:* The fireproof offices generously furnished by the University of Pennsylvania effect a substantial saving.

(3) *Abstracts on a non-honorarium basis:* Through the splendid cooperation of biologists throughout the world this procedure has conserved $10,000 annually.

(4) *Equipment:* The equipment of the central office is of the simplest kind, hardly sufficient to meet necessities.

(5) *Translating assistance:* In assembling the central staff, both scientific and clerical, attention has been given to linguistic equipment, with the result that writing, reading and speaking knowledge of German, French, Spanish, Portuguese, Italian, Danish, Norwegian, Swedish, Russian, Latvian, Polish and Czech is available without extra cost.

(6) *Section editors:* These editors, recognized specialists who perform the important function of editorial supervision of the manuscript in their respective sections, receive no compensation beyond a complimentary subscription and such books and separates as accompany the manuscript.

Though the saving thus effected exceeds $50,000 annually, the funds available were not sufficient and publication fell seriously into arrears. Experience indicated clearly that the original estimate of $75,000

was accurate. Meanwhile the literature was exceeding 40,000 titles, necessitating an adjustment in editorial funds, though not a pro-rata one. The Rockefeller Foundation accordingly granted permission to use a larger amount annually from the original commitment, beginning in 1929. This, together with the continuing grant of $128,000 in December, 1930, has made available for the four years, 1929, 1930, 1931 and 1932, an average annual sum of about $77,000.

The increased funds made possible augmentation of the scientific and clerical staff, and the work is going forward at more satisfactory speed. For a time large irregular issues were published to reduce arrears, but since January, 1930, the regular monthly publication schedule has been maintained. Also, it has been possible to work intensively on the indexes, the first one having been issued last December.

Something more should be said concerning the indexes. Current issues of abstracting journals largely serve to direct attention to current developments and progress. But more important in the long run is the use of abstracting journals in reference and orientation work. Any one who has tried to use an abstracting journal without indexes or with indifferent ones will agree that its permanent value depends upon the quality of its indexes. Therefore the editors have attempted to set a fairly high standard from the beginning. Though the indexes, too, are a matter of development, it is hoped that the first one holds out a definite promise that something approaching a precision instrument can be constructed. To construct such indexes is a scientific, not a clerical, task; the ideal will be approached in the measure that competently trained scientific personnel is available and the work carried on with the maximum understanding of the needs of investigators.

Estimated editorial costs for the next decade: Over a year ago the executive committee of the board of trustees of *Biological Abstracts* completed a study of the needs for the next decade, with the conclusion that $110,000 annually will be required to carry on the work properly, allocated as follows:

(a) Cost of handling 40,000 papers and books annually, exclusive of honoraria	$ 75,000
(b) Cost of handling the approximately 15,000 papers and books annually by which the literature will exceed the 1923 estimate of 40,000 made on the basis of the 1921 literature	10,000
(c) Abstracting honoraria	15,000
(d) Provision for growth	10,000
	$110,000

As already stated, the original estimate of $75,000 has proved accurate. As no funds were available for honoraria, there was no alternative to the voluntary procedure. Due to the remarkable cooperation of biologists, the plan has worked well, though in certain fields and languages difficulty is experienced. After careful consideration of the problem and of the experience of other abstracting services, practically all of which pay for abstracting, a modest honorarium seems highly desirable, both in justice to the abstractors and in the interest of promptness and completeness.

As will be apparent, the editorial cost of caring for additional literature is not pro rata; it is calculated that $10,000 will provide for the 15,000 papers and books in excess of the 40,000 estimated in the 1921 literature. Finally, provision must be made for growth. Estimates are hazardous; but the growth in research literature during the past ten years continues unabated, and there seems no reason to doubt its continuance in the next decade.

Viewed as a single sum, the funds required appear large. It is pertinent, therefore, to inquire how this cost compares with the cost of research and its original publication. In other words, how much does it cost to get new information and publish it and how much does it cost, relatively, to make this new information generally available through abstracts and indexes, *i.e.*, to take the final step necessary in view of the present complexity and volume of biological research?

Data now available furnish perspective in this direction. Two studies have been made, one in a university, the other of two institutions devoted wholly to research. These show that the total (editorial and printing) cost of *Biological Abstracts* per research paper is one tenth to one twenty-fifth of one per cent. the cost of the research and its publication. In other words, it costs one dollar to provide an abstract of research which to perform and publish costs from one thousand to twenty-five hundred dollars. The cost of the abstracting journal as compared with the cost of the research is thus essentially negligible; whether the service rendered, especially when complete and prompt, is worth this small expenditure should not be difficult to determine.

It may further facilitate perspective if the financial needs of the abstracting journal are seen in relation to the annual expenditures of some of the departments of biological science in a leading American university: Anatomy, $98,000; bacteriology, $91,000; biological chemistry, $77,000; botany, $53,000; neurology, $38,000; pathology, $96,000; pharmacology, $28,000; physiology, $57,000; zoology, $123,000.

It may be wondered why the needs of an abstracting journal are so much larger than those of research journals. It is impossible to compare editorial costs

in abstracting and research journals. The former can not escape heavy costs in this direction; in the latter, the editorial work is of such kind and proportions that, in America at least, it is usually handled without expense to the journals by voluntary services from individuals and their institutions. In short, the present financial problem of research journals is almost wholly one of paying manufacturing costs. In abstracting journals the major cost will always be the editorial, except in those rare cases in which the size of the edition reaches a point where the sheer volume of paper, presswork and binding involved makes the manufacturing costs the higher.

The reasons are obvious. The research journal usually has manuscripts thrust upon it in larger volume than desired. But the largest and most costly problem of the abstracting journal is precisely that of getting its material and attending to the enormous volume of exacting detailed work necessary to make the final product an adequate orienting mechanism with permanent reference value.

Biological Abstracts has been fortunate in having the benefit of the experience of *Chemical Abstracts,* which for over two decades has served chemical science with such conspicuous success. It is a pleasure to acknowledge the many courtesies and important help extended both by the editors and by the officers of the American Chemical Society. *Chemical Abstracts* is a notable achievement, not only because it has become an indispensable tool for chemists but also because, until recently, its cost was met wholly out of income of the American Chemical Society; not until 1929 did some outside subsidy become available to help maintain the journal on its high level of splendid service. It is therefore not surprising that biologists should inquire to what extent *Biological Abstracts* might become similarly self-supporting. This question deserves careful analysis. The following facts are pertinent.

The non-overlapping professional membership (about 9,000) of the nearly thirty North American societies concerned primarily with research biology is about one half the membership of the American Chemical Society (over 18,000). On the other hand, the research literature in biology is larger than in chemistry and is scattered in three times as many serials. Put in another way, biological literature is larger, more diversified and more widely scattered, and there are only half as many individuals to bear the cost of the abstracting journal.

The explanation lies in large part in the extensive penetration of chemistry into industry, which claims more than half the membership of the American Chemical Society. In biology the two great fields of application are agriculture and medicine; unlike the chemist in industry, however, the agricultural worker and the clinician are seldom members of the basic science societies and are therefore not supporters of an abstracting journal in biology.

The intimate application of chemistry in industry is reflected also in the substantial income from advertising built up in the journals of the American Chemical Society, aggregating $110,000 net in 1930 and constituting an important factor in maintaining the large coordinated publication program of the American Chemical Society, including *Chemical Abstracts.* So far the income from advertising in *Biological Abstracts* is but a few per cent. of this amount and is certain to remain a small fraction for years to come.

Such differences have an important relation to the conduct of scientific enterprises in biology. They bear out the conviction of the committee in planning *Biological Abstracts* that such a journal can not be self-supporting to the extent of providing for the enormous amount of abstracting, editorial, indexing and bibliographic work involved if the journal is to be published at a price within reach not only of larger institutions but of smaller ones and individuals as well. Without this general availability such a journal can not approximate its full usefulness.

Biological Abstracts is in the midst of its development. Its present shortcomings are obvious, especially the delays in publication of abstracts and indexes, though these are being reduced. However, the project has advanced far enough reasonably to demonstrate the correctness of the Union's original conclusion, namely, that a single inclusive abstracting journal for biology is not only possible but practical and economical as well, and sound on general principles. Its development can proceed as rapidly as editorial and subscription funds enable the editors to deal adequately and expeditiously with the editorial and publication problems involved.

The problems in biology are difficult, in fact, bafflingly elusive and complicated in many directions. Highly circumscribed and specialized attacks are increasingly necessary to penetrate a little further. In this circumstance it is inevitable that even restricted outlooks involve extensive synthesis of specialized data gathered from various fields. The more minute the analysis, the more extensive the synthesis needed to gain perspective and comprehension in the coordinated phenomena and processes of organisms. Analysis and synthesis therefore go hand in hand, the one providing the raw material, the other constructing the edifice. It is to facilitate both that the Union has undertaken to perfect a comprehensive abstracting journal in biological science.