THE DEVELOPMENT OF THE TEACHING OF GENERAL BIOLOGY IN THE SECONDARY SCHOOLS

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V. THE MATERIALS USED IN TEACHING BIOLOGY

It is impossible to completely separate a discussion of methods from one of materials. This chapter is designed to present a more complete discussion of teaching materials in the history of biology teaching than could be conveniently offered in the preceding section on the development of biology teaching methods.

TEXTBOOKS

The importance of the textbook in the early teachings of biological sciences and its continued high standing among teachers has been noted. A number of botany, zoology, and physiology texts had been written to meet the needs of those courses, but the introduction of a general course in biology carried with it a pressing need for a textbook. Colleges introducing the new subject could make good use of the lecture method, as Martin did in teaching the first American biology course at Johns Hopkins University, but extensive use of the lecture method has never been found suitable to secondary school teaching. An early attempt to construct a general biology textbook is described in a history of biology in Chicago schools by Whitney (1930, p. 151) as follows:

> Some one in authority now applied to the Appletons for their help, and Professor Coulter and President Jordan were delegated the task of preparing a textbook. As they had no model to guide them, they hardly knew how to combine in one book the forms and life relations of plants and animals. They finally compromised by each writing two books, *Plant Relations* and *Plant Structure*, and *Animal Life* and *Animal Forms*. These were good books. . . . But a practical difficulty arose when the teachers came to use the books. All the books were needed, but the pupils could not be asked to buy so many books. . . . Finally, to solve the difficulty a committee of three teachers was given the task of combining the two books in each subject into one book. This they did with fair success and the new books were published as *Plant Studies* and *Animal Studies*. These were very satisfactory books and were used for several years.

The Sedgwick and Wilson *General Biology*, first published in 1886, and republished in 1895, went a step further by incorporating the botany and zoology in one book, though with no attempt at correlation.

The organization of the book was based on the fern-earthworm two-type method, with two objectives, as may be concluded from the following prefatory remarks (p. v): "We have sought to lead beginners in biology from familiar facts to a better knowledge of how living things are built and how they act, such as may rightly take place in general education, or may afford a basis for further studies in general biology, zoology, botany, physiology, or medicine."

This text was probably used as a college textbook although the authors seem to have intended it for all beginners in biological science, high school or college. No human physiology was included, the fusion of physiology and biology not having begun until the first decade of the twentieth century.

Most of the early texts consisted of the three parts, botany, zoology, and physiology, frequently with an introductory part on general principles and a concluding chapter or so on economic applications or the history of the subject. Some authors, however, began to organize their textbooks around principles involving the treatment of both animal and plant life together. Perhaps the first American biology text presenting a *blended* or unified organization was that of Needham in 1910, which included the following units:

I. Interdependence of Organisms
II. The Simpler Organisms
III. Organic Evolution
IV. Inheritance
V. The Life Cycle
VI. Adjustment of Organisms to Environment
VII. Responsive Life of Organisms

The resultant controversy concerning the relative merits of the blended and tripartite organizations has by no means been settled, although a study of the following lists of books, grouped according to type of organization, indicates an increased use of the blended course, with an almost complete dominance of the blended type of organization in the numerous textbooks written in recent years.

Books Adhering Chiefly to the Tripartite Arrangement

Hunter, G. W., *Elements of Biology*.......................1907
Bailey, L. H., and W. M. Coleman, *First Course in Biology*.....1908
Hunter, G. W., *Essentials of Biology*.......................1911
Peabody, J. E., and A. E. Hunt, *Elementary Biology*..........1913
Bigelow, M. A., and A. N. Bigelow, *Applied Biology*..........1911
Hunter, G. W., *A Civic Biology*.............................1914
Smallwood, W. M., Ida L. Reveley, and G. A. Bailey, *Biology for the High School*..........................1920
Linville, H. R., *Biology of Man and Other Organisms*..........1923
Clement, A. G., *Living Things*..............................1924
Hunter, G. W., *New Essentials of Biology*...................1924

Smallwood, W. M., and others, *New Biology*................1924
Moon, Truman Jesse, *Biology for Beginners*................1926
Smallwood, W. M., and others, *New General Biology*..........1929

Books with United Organization

Needham, J. G., *General Biology*..........................1910
Abbott, J. F., *Elementary Principles of General Biology*........1914
Hodge, C. F., and J. Dawson, *Civic Biology*..................1918
Gruenberg, B. C., *Elementary Biology*......................1919
Atwood, W. H., *Civic and Economic Biology*..................1922
Peabody, E. J., and A. E. Hunt, *Biology and Human Welfare*...1924
Gruenberg, B. C., *Biology and Human Life*..................1925
Kinsey, Alfred, *Introduction to Biology*....................1926
Hunter, G. W., *New Civic Biology*..........................1926
Atwood, W. H., *Biology*..................................1927
Hunter, G. W., *Problems in Biology*........................1931
Meier, W. H. D., and L. Meier, *Essentials of Biology*..........1931
Wheat, F. M., and E. T. Fitzpatrick, *General Biology*..........1932
Pieper, C. J., W. V. Beauchamp, and O. D. Frank,
Everyday Problems in Biology..........................1932
Kinsey, Alfred, *New Introduction to Biology*..................1933
Mank, Helen G., *The Living World*..........................1933
Baker, A. O., and L. M. Mills, *Dynamic Biology*..............1933
Curtis, F. D., O. W. Caldwell, and N. A. Sherman,
Biology for Today....................................1934
Fitzpatrick, F. L., and R. E. Horton, *Biology*................1935

It is apparent that there has been within recent years a decided trend toward the *general* biology textbook. Hunter (1924) at first defended the differentiation of biology material into botany, zoology, and physiology, as follows:

> Ideally, we might take up general principles and draw from the great storehouses of plant, animal, and human biology to illustrate each principle before going on to the next. Practically, however, such a plan does not seem to be workable, partly because of the difficulty of collecting enough material to make such demonstrations possible. It is impracticable with immature students, because they cannot grasp the many-sidedness of the application at once. This will come only after repetition of the principle each time from a slightly different point of view.

His two latest books, however, "follow the approved unit structure". Two other early writers of textbooks, Peabody and Hunt, performed a right-about-face in their views concerning the organization of high school biology textbooks during the time that elapsed between the publication of their *Elementary Biology* in 1913 and the writing of *Biology and Human Welfare* in 1923. This change in view is expressed in the preface to their second book (pp. v-vi) thus:

> We have become convinced that a given function, for example, digestion or respiration, can be presented more effectively by considering in turn how the process is carried on in plants, in animals, and in the human body than by studying plants, animals, and man as separate units and completing the

> study of one before taking up the study of the others. . . . In studying the special function in the three spheres, boys and girls are led to see the essential likenesses in the work done by all living things rather than relatively unessential differences in structure.

The first textbook of Peabody and Hunt was typical of an organization centering around the human welfare aspect of the science which was very important in the development of the blended type of text. The purpose of the Peabody and Hunt (1913, p. ix) text as stated in the preface was:

> Is it not clear, therefore, if we are to outline a course in biology that will best fit the interests of the living material, *i. e.*, the boy or girl who is to take the course, that the central idea or factor must be man; that all the various functions considered must have some relation to human life; and that the course, to be of practical importance, must suggest to the youth better ways of carrying on his own life and of helping to improve the surroundings in which he lives.

An earlier aspect of the emphasis on human welfare in textbooks than the physiological treatment characteristic of Peabody and Hunt was the large amount of economic applications included in some of the earlier books such as Hunter's *Essentials of Biology*, which had a great deal of agricultural material. Gruenberg's textbooks, with their units on the biology of health and the biology of wealth utilized both. Still another aspect of the interest in human welfare as evidenced in textbooks was the effort to attain the objective of good citizenship, as apparent in the names of several of the texts listed above. The citizenship objective, so well expressed in the preface to Hunter's *New Civic Biology* (1926, p. vii) as "The trend toward better health and citizenship building . . . . it is hoped that this book will work toward the ideal development of efficient, thinking citizens," was also expressed by some of the other writers. It is interesting to note that Smallwood, Reveley, and Bailey omitted it after their first book, published in 1920.

An organization giving extensive attention to inter-relationships and the ecological viewpoint is apparent in many of the earlier textbooks and continues fairly important. A very recent emphasis on interrelationships is that given by Mank in her book, *The Living World* (1933). A prefatory statement maintains that "It continually stresses the thought of the special adaptations of living organisms for securing such primary necessities as food and oxygen, and maintaining themselves despite their enemies, and for providing for the continuance of the race. The interlocking relationships between plants and animals are again and again emphasized."

While the emphasis on ecology has remained fairly constant, there have been marked changes in the relative emphasis on other main phases, as shown in Table 7, which is a compilation of the averages of subject matter analyses made by the writer and two biology major students of Ball State Teachers College. The number of pages or tenths of pages, including illustrations but excluding experiments, questions, etc., devoted to each phase of biology were totaled for each text, and the percentage of space given each was determined from the resultant figures.

TABLE 7. *Percentage of space devoted to the different phases of subject matter*

Author	Year	Taxonomy	Morphology	Natural History	Ecology	Physiology	H'lth.	Heredity	Appreciation	Prac. Application	Miscelane's
Hunter*	1907	16.37	39.99	8.67	9.32	6.27	9.05	0.05	1.49	4.62	3.96
Bailey & C.	1908	11.79	39.36	9.50	4.74	16.28	8.85	0.55	0.26	5.96	2.67
Peabody & H.	1912	6.90	23.16	6.54	1.29	11.08	19.25	1.57	7.09	17.32	2.54
Hunter	1914	5.33	10.37	2.00	6.29	21.16	25.99	4.52	8.76	12.39	3.12
Hodge & D.	1918	12.95	2.23	12.93	0.89	0.21	13.26	4.68	14.16	35.98	2.42
Moon	1926	6.01	27.40	13.28	2.53	14.65	13.78	1.76	6.97	9.89	3.71
Atwood	1922	5.58	22.81	12.58	6.77	9.12	8.86	9.76	2.71	16.90	4.85
Clement	1924	4.73	12.33	8.47	3.74	27.13	20.34	3.28	5.12	10.19	4.62
Gruenberg	1925	6.14	13.59	3.98	4.42	13.48	29.00	7.08	6.11	12.91	7.54
Atwood	1927	9.04	19.91	9.65	7.63	7.15	9.14	6.60	9.76	18.84	2.11
Meier & Meier	1931	11.46	23.29	11.25	4.00	8.92	12.16	3.08	8.37	16.08	1.30
Pieper, B & F.	1932	5.94	14.93	13.06	15.15	15.96	10.58	3.68	5.46	14.93	5.61
Wheat	1932	3.63	11.48	9.92	10.72	14.80	5.30	11.74	13.44	14.38	4.64
Kinsey	1933	7.45	8.23	14.40	19.91	5.13	8.66	7.86	12.76	9.83	6.4[illegible]
Baker & M.	1933	4.67	3.73	20.46	9.23	6.93	11.20	7.27	16.28	7.11	2.97
Mank	1933	6.73	14.30	8.33	9.20	17.69	13.94	4.47	7.68	13.23	4.58
Fitzpatrick & H	1935	5.82	11.79	11.89	10.16	17.75	7.23	7.79	8.11	9.66	4.06

*The textbooks given in the table by the author's name are these:
Hunter, G. W. 1907. Elements of Botany.
Bailey, L. H., and W. M. Coleman. 1908. First Course in Biology.
Peabody, J. E., and A. E. Hunt. 1913. Elementary Biology.
Hunter, G. W. 1914. A Civic Biology.
Hodge, C. F., and J. Dawson. 1918. Civic Biology.
Moon, J. T. 1921. Biology for Beginners.
Atwood, W. H. 1922. Civic and Economic Biology.
Clement, A. G. 1924. Living Things.
Gruenberg, B. C. 1925. Biology and Human Life.
Atwood, W. H. 1927. Biology.
Meier, W. H. D., and L. Meier. 1931. Essentials of Biology.
Pieper, C. J., W. L. Beauchamp, and O. D. Frank. 1932. Everyday Problems in Biology.
Wheat, F. M., and E. T. Fitzpatrick. 1932. General Biology.
Kinsey, A. 1933. New Introduction to Biology.
Mank, H. G. 1933. The Living World.
Fitzpatrick, F. L., and R. E. Horton. 1936. Biology.

The very rapid decrease in the amount of space given to classification, apparent for the first two years, and the fairly stationary status of taxonomy in the textbooks of the last two decades is somewhat indicative that the reduction has reached a minimum amount.

Morphology, the predominant subject matter when biology was introduced, shows a loss of about 27 per cent. A scrutiny of morphological material as it appears in recent textbooks shows that authors are following the recent trend of utilization of structure only as a necessary basis for an understanding of function. Physiology, after its introduction, held rather a high, consistent ranking among subject matter units until very recently. Two of the 1933 textbooks analyzed gave very low percentages for it. There is, of course, a high correlation between the emphasis on physiology and on health.

The health objective as it affected textbook writing appears to have reached its ascendancy during the middle period from about 1912-1925 with a rather consistent decline thereafter. The rising popularity of health courses, in many states required by law, is undoubtedly a main factor in the decreasing attention given health in general biology textbooks.

Space given to heredity and evolution has progressed from a negligible amount in early texts to the quite respectable average of about 8 per cent for the books of the last decade. Practical applications, after the impetus received in early texts, have continued to receive a large share of emphasis in general biology books, although the Kinsey and the Baker-Mills textbooks for 1933 seem to have neglected that phase altogether.

Ecology, after a decline during the middle period, seems to be staging a come-back with natural history. The rising percentage of natural history and ecology coupled with the huge gain in percentage of space given to appreciational material—such as leisure time activities and lives of great biologists—during the last three or four years are significant in that they demonstrate the recent trend of biology texts toward the psychological approach in biology work for high school people. There are two main points, not strictly separate, to be considered in the organization of recent textbooks according to the dictates of psychology: (1) the earnest attempt to secure the pupil's interest and (2) the emphasis on problem-solving and the scientific attitude.

Kinsey states as his main aim in preparing his text, *Introduction to Biology,* the desire to lead the pupil to discover "that it is an interesting world in which we live". Table 7 indicates that Kinsey's text is second highest in space devoted to natural history. The Pieper, Beauchamp, and Frank, and the Baker and Mills books also seek to interest the pupil through a larger inclusion of natural history material. Kinsey (1926, p. v) also adds interest to his book by a very informal conversational style which he defends in the preface to the book in this way: "In attempting to interest, I have neglected some of the formalities of written language. I have avoided technical terms wherever possible. I have told stories in places, just as I have told stories to the boys and girls of my classrooms and camps and trails. I have tried to apply biologic principles to the incidents of everyday life."

Mank also uses the conversational manner in presenting subject matter, as do Baker and Mills in their unit previews. Indeed, the textbook of the latter even contains a playlet as the preview to its first unit. The Baker and Mills *Dynamic Biology* is a strong competitor with Kinsey's book for first ranking on interest of illustrations. It is certainly a far cry from the earlier books with their excessive use of line drawings illustrating structural detail and laboratory apparatus, or at best, half-tones of plants or animals merely as specimens with no indication of activity, to the modern textbooks with their great array of diagrams, half-tones, and even colored plates, many of them showing animal activity and having definite human interest appeal. Hunter (1934, p. 234) writes of the importance of modern textbook illustrations in motivation:

> Not only does the modern science textbook introduce the student to science in an attractive way, but it also provides him with graphs, diagrams, half-tones even colored illustrations, which are visual reinforcement and which serve as motivating devices. The modern use of illustrations with the definite attention called to salient points in the pictures by means of problematically stated legends form some of the most valuable modern adjuncts to teaching.

Another way in which modern textbooks attempt to interest the pupil is the inclusion of material on leisure time activities, a definite response to the recommendation of the Science Committee of the National Education Association Commission for the Reorganization of Secondary Education in 1920, for more attention to the leisure time objective. "On the Trail With Camera, Rod, and Gun" is the title of a long chapter in one of the recent books (Baker and Mills, 1933) and many of the books contain either chapters on leisure time activities or scattered lists of interesting things to do. The recommendation of the committee for humanizing biology by greater attention to the appreciational study of famous biologists and the contributions of science to progress has also been met by almost all recent authors.

The study of the work of famous biologists has also been one method utilized by textbook writers for the development of the scientific attitude. The importance attached to the acquirement of the scientific attitude is clearly demonstrated in Table 4. Some authors have gone little beyond a prefatory statement of the modern scientific objective, while others have definitely organized their books around that objective. Kinsey devotes a chapter to it in his *Introduction to Biology,* while other authors use less obvious methods.

Some of the early textbook writers, continuing in the hope that quantities of laboratory work would automatically develop scientific thinkers, included large numbers of laboratory experiments. Many recent authors have included a comparatively large number of experiments but in a different manner. Names of such texts as Pieper, Beauchamp, and Frank's *Everyday Problems in Biology* and Hunter's *Problems in Biology* indicate a modern tendency to organize textbooks around important problems which involve experiments, among other things, in their solution. Baker and Mills, and Wheat and Fitzpatrick also use the problem organization. The problems as presented and directed, represent the adaptation of biology material to recent psychological findings concerning the nature of learning and the possibilities of transfer in development of the scientific attitude.

All of the texts which use the psychological unit organization employ a preview, and most of them provide self-testing devices so that the pupil may be able to determine when he has satisfactorily completed a problem or unit. A great variety of exercises are included as provision for individual differences. Mank and Kinsey are among the authors who consider that observation is a very essential factor in the scientific method, and they include more observation exercises than laboratory experiments.

Hackett (according to Knapp, 1933, p. 58), in an analysis of high school textbooks, emphasizes the importance of generalizations as necessary in the development of the scientific attitude:

> One of the major problems of educators today is the problem of the generalization of experience. Wherever a student has seen the possibility of analyzing various situations and discovering productive relationships between these different particular situations, he will be stimulated to treat new problems in the same way. . . . So it is in the field of biology and in all fields of science. Through the process of comparison and contrast one finally arrives at some generalization relative to the function or structure; of one plant or one animal with another plant or another animal as the case may be. It is through this power of generalization that the student actually gains a lasting impression and one which is thoroughly understood by him.

Table 8 includes some of the results of his analysis of prevalent texts for space devoted to generalizations, as tabulated by Knapp (1933, p. 59). Hunter, Gruenberg, and Atwood stood high while others of the list were fairly low in development of generalizations and so might not be expected to be as helpful in the development of the scientific attitude.

TABLE 8

Percentage of space in various biology texts devoted to generalizations and the generalizations to which each devotes more than twenty pages

Name of Text	Percentage of Space Devoted to Generalizations	Generalizations to Which Over 20 Pages of Space are Devoted
Hunter	47.58%	Ecology Nutrition
Gruenberg	43.46	Ecology Nutrition Comparative Physiology
Atwood	39.06	Ecology Nutrition
Moon	33.90	Ecology Nutrition Evolution
Smallwood, Reveley and Bailey	27.22	Nutrition
Peabody and Hunt	23.10	Nutrition Reproduction

A study made by Knapp (1933, p. 56) for the relative prevalence of various textbooks in California is given in Table 9 together with the percentage prevalence for the year 1921 in 53 cities of over 100,000 population, as found by Richards (1923, p. 414).

TABLE 9

The number and percentage of schools using the various biology texts for the years 1917-18, 1921-22, and 1926-27

Biology Texts Used	1917–18		1921–22		1921	1926–27	
	No.	%	No.	%	%	No.	%
Hunter	80	63.0	98	51.9	26.4	49	18.7
Peabody and Hunt	36	28.3	13	6.8	15.1	24	9.2
Gruenberg			58	30.6	15.1	70	26.8
Moon						74	28.4
Smallwood, Reveley and Bailey	6	4.7	11	55.9	5.9	39	14.9
Bigelow	5	4.0					
Hodge and Dawson			8	4.2	5.9		
Holmes			1	0.6		2	0.8
Linville						2	0.8
Atwood						1	0.4
Total	127	100.	189	100.		261	100.

The two studies show much the same tendency in preference for textbooks during the years 1921-22, a tendency toward selection of books emphasizing generalizations, while Knapp's study for 1922-27 shows a "decided trend toward the more formalized type of text". The prevalence of textbooks using the problem approach among those written since 1930 would seem to indicate a demand for texts developing generalizations, although no data concerning the extent to which recent textbooks are used are available.

In his book on science teaching published in 1934, Hunter remarks on the trend of texts toward formalization (p. 246): "Encyclopedic texts in science seem to be much in vogue just now. This is probably because their authors have attempted to meet the demands of already overcrowded courses of study, and in this attempt have filled their texts with a surplus of factual material, much of which is unrelated to problems of social worth-whileness."

How similar is this criticism to one written by Jean Dawson (1909, p. 653) twenty-five years earlier: "The high school textbooks contain the most modern biological thought and theory that is advanced in our universities. . . . They are so complete that they form compendiums from which I have seen graduate students studying preparatory to taking an examination for the degree of Doctor of Philosophy."

While it may appear that there has been no progress along this line, improvement in interest and psychological development is decidedly evident in most recent texts.

Workbooks

With the introduction of the extensive use of the laboratory, as we have seen, there was a deluge of laboratory manuals. Recent years have seen a similar deluge of workbooks, descendants of the old type laboratory manual. Many of them show their ancestry very definitely in their formal organization into object, materials, procedure, results, and conclusion. A survey of eleven workbooks published since 1930 revealed four of them using largely the old formal type of organization. Some of the later laboratory manuals, such as *New Laboratory Manual* by Bailey and Greene (1928), are more progressive in organization, at least in the omission of the conventional laboratory outline.

The organization of the true workbooks depends largely on the purposes for which the authors made their workbooks, and the better ones show definitely the influence of discoveries in educational psychology and suggestions made by progressive organizations like the National Education Association. A number of different purposes have been given. One of the first workbooks to appear under that name, *A Biology Workbook,* by Adell, Dunham, and Walton in 1929, offered as its purpose (p. iii): "The fundamental aim of the book is to give the student an opportunity to work through valuable life experiences, in the accomplishment of which he will be interested and happy."

They set about accomplishing their purpose by utilizing the problematic approach and giving interesting captions to topics such as *Does it hurt the honeybee when it stings you?,* by including units on leisure time and great scientists, by the provision of a number of optional problems to take care of individual differences, and by the use of interesting half-tones and drawings. Many of the other workbooks recognized the importance of pupil interest in their presentation of work, and the motivation value of workbooks is considered one of the main points in their favor.

Biology Notebook by Meier and Meier (1931, p. iii), demonstrating in name the tendency of workbooks to supplant notebooks, states that "It offers a number of different ways of expression, all of which appeal to the students in secondary schools". Whether all of the means of expression included in the workbook had great appeal for the pupil or not, the purpose of the workbook is at least stated to be pupil-activity. "The best reason for using this book is that it is yours," Hunter (1932, p. 3) says to prospective pupil-owners of his *Laboratory Problems in Biology,* and urges that they be original. Most of the workbooks name as one of their important features the adaptation to individual differences by inclusion of many and varied problems.

Homer Clark's workbook (1932, p. 2) "is designed to constitute a course of minimum essentials for students of biology." He is apparently suggesting that biology workbooks be made drill books as in other fields.

Practice in problem-solving was given as a purpose of many of the later workbooks, as stated in Walpole's *Work Units in Biology* (1931, p. iii): "The purpose of *Work Units in Biology* is to tie up the work of the classroom or laboratory with the everyday problems of living things." Some of the workbooks carried the problem-solving purpose higher to the purpose of developing the scientific attitude or the art of thinking, as Helen Mank termed it in her workbook published in 1935. Seven of eleven workbooks which were written since 1930 and which were studied, expressed this purpose in some form, but the extent to which they attempted to fulfill the purpose varied. Some of them used the old conventional laboratory outline, which is not very conducive to scientific thinking or originality, and the problematic approach in two or three of them professing the problem-solving purpose was nowhere apparent. Some of them, such as Fitzpatrick and Horton's *Student Manual in Biology* (1935), and Beauchamp's *Study Book in Biology* (1934) gave definite suggestions concerning the use of the scientific method throughout the workbook. McAtee and Downing's *Problem-Solving in Biology* (1934) included a unit on scientific thinking and a list of ten commandments for scientific thinking.

A few of the workbooks gave as one of their objectives the inculcation of scientific principles or concepts. In Walpole's *Unit Studies in Biology* (1935), basic concepts are conspicuously boxed. Recent emphasis on concepts is no doubt due in part to the recommendation of the Thirty-First Yearbook of the National Society for the Study of Education, for more biology teaching built on concepts.

Roy and Ira Davis (1932, p. iii), in their workbook, stressed the importance of the book in making the teacher's work easier and more efficient:

> A workbook should make it possible for the teacher to give more individual attention to the pupils by reducing the time required for the preparation of assignments. It should also make it possible for the teacher to check the progress of each pupil with a minimum amount of time. . . . It makes it possible for the teacher to diagnose the difficulties that pupils are having and to record the progress each pupil is making.

Hunter's workbook (1932, p. 3) emphasized the value of the workbook in lightening the pupil's burdens:

> A workbook helps make work easier and more interesting. It saves drudgery and waste of time in the laboratory because it supplies outlines for you to fill and label. Instead of wasting hours in making drawings you may use that time in learning more about the living things you see and how they behave. The tables which are given for you to fill out are labor-saving devices made to help you to organize your work so that you can use it in making reports or recitations.

The controversy as to the importance of drawings in biology work is apparent in the workbooks. Of the fifteen studied, two required drawings of apparatus, two required other drawings, four gave diagrams for labeling, and eight offered a combination of diagrams for labeling and drawing space for talented pupils. Two offered so-called skeletal drawings, in which the outline of the drawings is given, and the pupil is left to fill in the essential details and the labels. This is a recent compromise between the two extremes of requiring the pupil to make elaborate drawings and of allowing the pupil merely to label diagrams given. The first practice has been condemned as a waste of time, while the latter tends toward pupil boredom and loss of initiative.

Several of the workbooks, notably Adell, Dunham, and Walton's, Walpole's, and Kinsey's, have attractive half-tones and illustrative drawings, while the McAtee and Downing workbook has delightfully amusing drawings to introduce each unit interestingly. The latter book probably puts more emphasis on interest than does any of the others.

Another feature of recent workbooks is the inclusion of a testing program. Two of the fourteen studied gave pretests and nine gave objective tests at the conclusion of each unit or at the end of the book, some of them self-tests, some review and unit-analysis tests, and some achievement tests.

Figures on workbook sales are not available, but from the large number being written, it seems that there must be a large demand. The idea is too new to be definitely viewed either as a passing fad or as a permanent addition to teaching method, but it does have certain advantages which are very well summarized by Hunter (1934, pp. 276-277):

> The workbook, while it may go to the extreme of over-mechanizing the activity of the pupil, does nevertheless have very definite values. It helps the pupil to use and organize his knowledge, thus making for purposeful self-activity. It aids in mastery because it gives the pupil definite paths to complete learning. Through its many types of questions and problems, it gives the pupil practice and facility in meeting new situations. It provides material for training and especially self-testing through practice tests, tables, and interpretation of graphic material. It provides for individual differences in a way that the laboratory or classroom examination does not do because it presents the child with new situations, thus making for real thinking on his part. From the teacher's standpoint, the workbook is a time saver as it eliminates the use of the mimeograph, blackboard, copying, and avoids all unnecessary corrections of written work. Provided the workbook is properly constituted so that it does not involve filling in of memoriter material from the text and so long as it does not mechanize and formalize the course of study, it has a place as a motivating device.

Courses of Study

Courses of study have been, and continue to be, highly important teaching materials, especially to inexperienced teachers who find difficulty in getting the course organized. Furthermore, since many states require pupils to pass state final examinations based on the courses of study, it behooves teachers to employ the subject material recommended by the course of study if not the suggestions on organization, methods, textbooks, and enrichment material which most courses of study include.

Frequently textbooks are based on existing courses of study. Curtis, Caldwell and Sherman wrote (1934, p. v) in the preface of their book that "The content of this book has been carefully checked against a large number of representative state and city syllabi and will be found to include the materials required by these syllabi."

On the other hand, organizers of courses of study often find it helpful to base the courses very largely on one or two basal texts, although they may give references to others. Table 3 shows a rather high correlation between objectives as stated by textbooks and by courses of study. The courses of study used in the table seemed to be more progressive in fostering the leisure time objective than textbooks, and were first to drop health, as might be expected, since the decline of the health objective in general biology is largely due to state legislation requiring separate courses in health education.

Webb and Vinal (1934, pp. 829-830) have made a very comprehensive study of subject matter emphasis in courses of study, from which they drew the following conclusions, which will be seen to be very similar to the trends in textbook subject matter:

> Our study reveals that the practical and interesting topics in biology are being stressed. Highly technical matters not directly pertaining to everyday life were either omitted or not as frequently used as the more practical topics. . . . There seems to be a greater emphasis on social and economic aspects of biology. The main division entitled "Heredity, Environment, and Evolution" is perhaps the most far reaching of the entire survey. It is purely a trend towards the sensible and sane study of society. Eleven of the thirteen courses of study are represented in this division. The economic phase of this conclusion is drawn from the fact that a great many of the sub-topics read such as this . . . "Economic importance of . . . ", about nine of the courses constantly use this sub-topic heading in the study of many of the topics.

Tests

Tests have a variety of uses as a part of biology methods. From the teacher's standpoint they have value in that they (1) measure pupil progress, (2) allow diagnosis of difficulties of individuals, (3) help in emphasizing important principles, (4) aid in review of factual material, (5) offer a partial basis for promotion, (6) may be used at the beginning of a period as a "settling" device, (7) help set up a standard of achievement for different classes, (8) as pre-tests, determining what is to be taught, (9) serve as a test of teacher efficiency, and (10) act as motivating devices.

For the pupil, tests have these values: (1) mastery of subject matter essentials, (2) assistance in organization of material, (3) diagnosis of own weaknesses and strengths in science knowledge, (4) aid to thinking, (5) interest, and (6) practice in the art of test-passing in preparation for college entrance and other types of tests.

The advantages of tests, as enumerated above, apply chiefly to modern type tests. Examinations have always been important, as a basis for promotion if nothing else, but great changes have been made in their organization and the use made of them. The old type was exclusively an essay test, whose chief advantages and disadvantages are well discussed by Cole (1934, p. 172) thus:

> The essay examination has fallen into disrepute largely because it fails to satisfy the prerequisites of a good examination; because it is subjective in nature and is time-consuming for both pupils and teacher; because it encourages verbosity on examination; and because . . . due to its broad, general question it samples insufficiently the subject-matter which the examination usually covers. Its chief inherent advantage is that it gives the pupil an opportunity to organize his knowledge of the subject-matter covered, but excessive questioning often defeats this purpose and results in poor organization of material and poor English usage. The objective examination is, therefore, rapidly replacing the essay-type examination, although the ancillary use of the essay-type examination is probably wise.

The new-type of objective tests have a variety of forms. There are true-false, classification and rearrangement, matching, completion, labeling or identification, multiple response, informational outline, and individual laboratory performance tests. Most of these are factual tests, although some of them such as the multiple-response, may lend themselves to measurement of reasoning ability. Some of the more recent tests, such as the *Jordan-Noran Biology Tests* (1926), the *Oakes and Powers General Biology Test* (1929), and Downing's *Some Elements of Scientific Thinking* (1933) attempt to measure the ability to apply biological principles to the solution of concrete problems. Development of reliable tests of scientific attitudes will greatly aid the development of effective methods for attaining that objective.

Some attempt has been made at the construction of tests measuring the attainment of another recent aim, the appreciational. Efforts along this line have had scant success because of the difficulty of making the tests really objective, and because of the lack of validity of the results.

The main use of modern tests is in connection with various psychological unit plans. There are pre-tests, because psychologists recognize the importance of building on the pupil's earlier experiences, and because emphasis on material already familiar is not only a waste of time but a source of boredom. There are self-tests for the pupil in some of the recent texts like Hunter's *Problems in Biology* (1931) to help the student organize his knowledge about the main essentials. There are mastery or achievement tests to determine whether one unit has been satisfactorily completed. There are a number of standardized tests which not only fulfill the above needs, but offer the advantages of greater reliability, more ease of grading, and a national norm by which to measure one's own particular class. Testing programs are an outstanding part of most classes, but more emphasis should probably be placed on the instructional, motivational value of tests than on their use as measurements serving as the basis for ranking and promotion.

Visual Aids

Perhaps the most important recent development in biology teaching materials is the addition of a number of devices collectively called *visual aids.* There are perhaps two major reasons for the attention these devices have received: (1) the discovery that they serve to reduce the time and energy involved in learning, especially with children of subnormal intelligence, and (2) their value in stimulating interest.

Some earlier writers of natural history textbooks recognized the interest element by including many pictures of strange animals. Recent textbooks, as has been noted, have made signal advances in illustrative material. Charts and models were another development of the twentieth century and a decade or so ago were so extensively used as almost to constitute the characteristic method of a period. Huebner found (1929, p. 70), in an investigation of the relative merits of charts, models, and teacher's drawings that "Both boys and girls learn structures best by the aid of models. Both learn least by the aid of charts." Hunter (1934) also mentions the possible teaching value of a rather old device, the stereoscope.

In recent years, however, the microscope and various types of projection devices have so dominated visual education that discussions of visual aids are usually limited to such apparatus. The microscope is old in the history of biology teaching, but new inventions, especially the micro-projector, have served to increase its potentialities.

Other types of projectors which have been found useful in biology teaching are the balopticon, which projects opaque objects as well as lantern slides; the regular lantern slide projector, which, because of its cheapness and the fact that lantern slides are more readily accessible than films, is perhaps the most frequently included in high school equipment; and film projectors.

There are film strips, which are like lantern slides in that they consist of "stills", but are more convenient, in that the sequence is arranged on one strip, avoiding the frequent rearrangement necessary with slides.

Movies and sound films are probably the most interesting of the new visual aids. Moving pictures have been used for several years and have been experimentally proved successful. A number of good biology films are available. Moving pictures, under correct conditions of light and ventilation and when properly correlated with the plan of instruction, may have the following values: (1) they save time by supplanting certain field and factory excursions, and make available field situations unaccessible because of distance; (2) they show more clearly, by slow motion and time lapse effects, such processes as the growth of plants; (3) they serve as excellent motivation; (4) they demonstrate processes difficult to describe; and (5) they serve as an interesting review.

With the introduction of sound films or "talkies", educators immediately started testing the value of the invention as a classroom aid. Two types of apparatus may be used. There may be either the sound-on-film set-up which is in most cases prohibitively expensive, or a synchronizing device for a film and a phonograph record. Some studies, however, do not indicate that sound films are worth the added expense. Clark (1933, p. 22) drew the following conclusions from his experiments on the use of sound motion pictures as science teaching aids:

> . . . These are significant differences, and indicate clearly the superiority of the printed caption over this lecture type of sound film. The use of a spoken lecture, therefore, in place of printed captions, in an educational moving picture is most likely to detract from its value in conveying specific information.

It was suggested, however, that sound films might well replace very difficult lecture-demonstrations.

Living and Preserved Materials

The predominance of laboratory study of types, with the detailed dissection of preserved animals during the early years of biology teaching has been noted. There are still a few teachers who use the antiquated type method, and many more find legitimate, though limited, uses for preserved materials. Dissection-demonstrations are of value in illustrating structure, and preserved forms of unfamiliar plants and animals may add interest. Such things as mounted insects, birds, animals, and skeletons, bottled reptiles and amphibians, etc., serve to lend a science atmosphere to a biology classroom.

Some schools have access to the preserved materials of museums, which are frequently so arranged as to have great teaching value. In some of the larger cities, there are not only schedules for regular museum visits, but museum exhibits are sent to the schools. Hunter cites (1934, pp. 315-316) the practice of the American Museum of Natural History which since 1904 has sent to New York City schools various traveling collections.

There are also some good traveling exhibits of live animals arranged by various organizations. Within recent years the tendency has been for more and more substitution of living material for dead. The field laboratory is advocated, and the atmosphere is created indoors by extensive use of vivaria, aquaria, and teraria. Pupils of the school may even be sufficiently interested to carry out such projects as providing the school with aviaries for the study of birds and with out-of-door pools and flower collections.

Other Teaching Materials

A survey of biology teaching materials would hardly be complete without some mention of laboratory equipment. Part of the equipment, such as the microscope, has already been mentioned. Laboratory equipment of the older type probably ranked second only to textbooks during the first two or three decades of the teaching of biology. The amount and type of laboratory materials in recent years, except for what is left over from a previous period, is apt to depend largely upon the prevalent method of science teaching in the schools, and methods vary greatly, as has been pointed out.

Caldwell (1935) has summarized the development of visual aids as follows:

> The biological equipment twenty-five years ago was meagre as to living things, and graphic representation of habitats and life relations. Compound microscopes, preserved materials, and well stained slides were regarded as indispensable. . . . Biology class-rooms now contain living things, photographs and no end of illustrative material. In New York City the biology teacher may choose from nearly a hundred motion pictures depicting different biological matters.

Whether the splendid visual aids which are a recent development are as accessible to pupils throughout the nation as they are to New York City pupils is another question. In a thesis on the history of biology in Alabama, written in 1931 by Farr, the following statement occurs (p. 88):

> All high schools have a set of prepared slides, materials for making hand lenses and at least one microscope. Specimens of common woods, collected or purchased, mounted specimens of butterflies, charts based on human physiology, and combination charts of plants and animals are found in a small per cent of schools.

It is apparent that in one state, at least, visual education, if any, is largely of the antique variety.

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VI. INFLUENCES AFFECTING THE TEACHING OF BIOLOGY

The history of the teaching of general biology in the secondary schools reveals frequent changes in content, method, and aims. It is the purpose of this chapter to discuss some of the more important influences which had a part in bringing about these changes.

THE CHURCH

In the early history of natural science, before the introduction of biology, the church was a most important power in determining objectives, subject-material, and, to some extent, method. The religious aim was perhaps the dominant aim in early botany, as witness the prefaces to prevalent texts such as Gray's (1858, pp. 1-4). The first years of zoology found a number of texts written by clergymen, who, while trying to popularize natural science, also emphasized the theological aim. Many of them were catechetical in nature, betraying the profession of their authors. The textbook method then dominant was undoubtedly similar to the catechetical method of teaching church precepts.

Even Agassiz, earnest researchist that he was, insisted that religious benefits accruing from the study of zoology were as important as the scientific values. In his textbook, *Principles of Zoology* (1853, p. 34), occurs the following statement of the current religious aim:

> It is only as it contemplates, at the same time, matter and mind, that Natural History rises to its true character and dignity, and leads to its worthiest end, by indicating to us, in Creation, the execution of a plan fully matured in the beginning, and undeviatingly pursued; the work of a God indefinitely wise, regulating Nature according to immutable laws, which He has himself imposed on her.

By the time of the advent of biology, however, the religious aim had largely been abandoned. Popular textbooks after about 1880 gave it negligible notice, if any; and its use was discredited by teachers and scientists, as shown in the following citation from Ganong (1910, p. 70):

> We are also sometimes told that the study of nature ought to illuminate in clearer light the works of the Creator; but this also, I think, is not so. Those who have searched nature most deeply do not find therein any direct evidence of his working, and whatever of the kind one is to find there must first be read into it beforehand. But the moment one reads into science any preconception whatever, that moment it ceases to be science.

A revival of the influence of the church was evidenced in the controversy over the teaching of evolution in the schools. The theory of evolution has existed in one form or another for centuries, but the first really convincing theory was that of Darwin, as first submitted in his *The Origin of Species* (1859). The English clergy attacked the theory most energetically, but it, nevertheless, gained rapidly in popularity.

In America, however, scientists were slow to accept evolution as a plausible doctrine, and when they did, American religious opposition was as bitter as it had been in Europe. Church-dominated schools naturally opposed its teaching. One Professor Duffield of Princeton, according to White (1896, Vol. I, pp. 79-80), was so disturbed as to condemn its advocate to a very doubtful fate:

> If the development theory of the origin of man shall in a little while take its place—as doubtless it will—with other exploded scientific speculations, then they who accept it with its proper logical consequences will in the life to come have their portion with those who in this life "know not God and obey not the gospel of His Son."

One of the most effective weapons of the churches against evolution was the denominational control of the leading colleges during the early years of the theory. Professors who felt themselves obliged to teach scientific truth, even if they became convinced that the doctrine of evolution was part of it, were promptly relieved of their opportunities to disseminate the theory. Dr. Winchell of Vanderbilt Univercity; Dr. Woodrow of the Presbyterian Theological Seminary, South Carolina; Professor Toy of Louisville Baptist College; and most of the younger professors at Beyrout American College were among those who were ousted, during the two decades after 1870, for holding views on evolution contrary to those of the church (according to White, 1896, Vol. I, p. 129). Since new ideas in science reached the secondary schools largely through professor-written texts and college-trained teachers, the progress of evolution in the secondary schools was delayed. A recurrence of the same type of warfare occurred in the third decade of the twentieth century when a number of professors of denominational colleges resigned or were suspended for their views.

It was during the latter period that the controversy directly affected secondary school science teaching. The most effective attack was launched by several Fundamentalist organizations, notably the Bible Crusaders, organized in 1925 by George Washburn, and The Supreme Kingdom, organized in 1926 on the plans developed by William Jennings Bryan and Roscoe Carpenter.

The churches backed these organizations actively, and in addition, officially reported themselves against the teaching of the theory. In 1922 a state-wide meeting of Protestant clergy in Minnesota was called for the express purpose of organizing opposition in the form of resolutions against the study of evolution in the schools of the state. In the same year the Oklahoma and Texas State Baptist Associations and a Congress of the Disciples of Christ, took the same stand.

So vigorous was the attack of organizations, churches, and the general public that a number of state legislatures were forced to consider bills provided for a legal ban on the teaching of evolution. Few of the bills became laws, however. Florida has a house concurrent resolution dating back to 1923 which, according to Shipley (1937, p. 137) states:

> Be it Resolved by the House of Representatives, the Senate concurring: That it is the sense of the Legislature of the State of Florida that it is improper and subversive of the best interests of the people of this State for any professor, teacher or instructor in the public schools and colleges of this State, supported in whole or part by public taxation, to teach or permit to be taught, Atheism or Agnosticism, or to teach as true Darwinism, or any other hypotheses that links man in blood relationship to any other form of life.

Also in 1923 the Oklahoma free textbook law was enacted with an amendment requiring that "No copyright shall be purchased or textbook adopted that teaches the materialistic conception of history, *i.e.*, the Darwin theory of creation versus the Bible account of creation (Shipley, 1927, p. 335)." This amendment was repealed three years later.

Tennesse passed a law in 1925 which affected teachers. Section I reads as follows:

> Be it enacted by the General Assembly of the State of Tennessee, That it shall be unlawful for any teacher in any of the universities, normals, and all other public schools of the state, to teach any theory that denies the story of the divine creation of man as taught in the Bible, and to teach instead that man has descended from a lower order of animals (Shipley, 1927, p. 194.)

The law required that violation be punished by a fine of $100-$500 for each offense. Although opposition to the law in the legislature was negligible, Governor Peay suggested at the time of placing his signature on the bill that the probability of its becoming an active statute was slight. The case of a Dayton teacher soon proved him in error. John Scopes was tried and found guilty, and he only escaped the penalty by a reversal of the lower court judgment on a technicality, the supreme court ruling that the law itself was valid (Shipley, 1927, pp. 201-235).

A similar statute was enacted by the Mississippi legislature in 1926, forbidding the teaching of any theory that man descended or ascended from a lower order of animals, under penalty of a fine not exceeding $500 and cancellation of the teacher's contract. This law also prohibited the use of textbooks containing such a theory of evolution.

The latest anti-evolution law passed was that of Arkansas in 1928. The bill, very similar in wording to that of Mississippi, after which most of the subsequent bills had apparently been patterned, was interesting in that it was submitted to initiative and referendum vote of the people with the following results (Adams, 1930, p. 5):

For	108,991
Against	63,406

Only three states at present have anti-evolution laws in force. Fay (1930, p. 427), in a study of twenty-six of the defeated bills discovered the following facts concerning legislative action on the controversy:

> It is evident from the table that the Fundamentalists' attack has been most vigorous in the South. Only ten of the twenty-six bills were submitted to

the legislatures of states north of the Mason and Dixon line; and three of these were in border states. In four southern states, Texas, Louisiana, Arkansas, and Florida, the bills were passed by the lower house; the senates avoided taking a public stand in each case by postponing or tabling the bills.

The degree to which the war against the theory has influenced teaching in states where no legislation has been obtained has not been ascertained, but it is probable that teachers yield to public sentiment against it in communities where such sentiment exists or lose their places if they persist. After a journey through the state of Nebraska, Dr. Henry Fairfield Osborn made the following observations (Shipley, 1927, p. 325) on the teaching of evolution in that state:

> I was . . . amazed to learn from an extremely able high school teacher in the western part of the state that the word evolution was not to be used at all; so powerful is the influence of a certain class of theological teachers on their congregations, so strong is the influence of their congregations with their representatives in the state legislature, and so potent are these representatives in affecting state appropriations for education, that no teacher in the whole state of Nebraska is entirely free to be sincere but is more or less obliged to dissemble his real beliefs.

That the anti-evolution movement was still existent in 1930 is attested by the following statement of Maynard Shipley, president of the Science League of America (1930, p. 330):

> . . . It is but natural that the general public should assume that "the fight is over, and science has won."
>
> Nothing could be further from the truth. The Fundamentalists have merely changed their tactics. As one of their leaders has worded it, "We were too precipitate; we must go directly to the people themselves and not depend on the legislators." Primarily they are concentrating today on the emasculation of textbooks, the "purging" of libraries, and above all the continued hounding of teachers.

Women's Christian Temperance Union

The churches were also in league with another very influential organization, which had a part in dictating the subject matter of biology courses, The Women's Christian Temperance Union. It was organized in 1874 and started its campaign for temperance teaching in 1879. In an editorial in *School Life,* the official publication of the Bureau of Education in 1919, the following comment, according to Fay (1930, p. 443), on the early work of the union was made: "The full story has never been told of how Mary H. Hunt went over the country appearing before legislative committees and urging the acceptance of her plan. In the early eighties the results of her efforts began to be apparent, and by 1867 the propaganda had taken root in every part of the country."

Powerful lobbies, formed soon after the organization of the Women's Christian Temperance Union, forced legislation requiring the teaching of temperance hygiene in elementary and secondary schools. The first victory was won in Vermont, where a law was enacted in 1882 necessitating the teaching of the harmful effects of alcohol and narcotics in all public schools. Ferguson (1902, pp. 236-237) furnishes the details of the New York campaign in 1884 as given by the leader of the campaign:

> The campaign was systematically planned and executed. Earnest appeals from platform, press, and prayer-meeting among the constituencies back of every vote created a sentiment that echoed in the final "aye, aye," that enacted the law of 1884. . . . More than a million pages of matter in print and letter form went out during that campaign to the people of that state.

A federal law, with similar requirements, but applying to the District of Columbia and all nationally controlled schools, was passed in 1866. By 1902, according to Fay (1930, p. 438), all states had laws requiring temperance teaching. However, a dissertation written by Babcock in 1902 (p. 13) states that Georgia had no such law at that time.

Hunter (1934, p. 29) named the Women's Christian Temperance Union as one of the factors producing the era of physiology in the biological sciences, occurring about the first decade of the twentieth century. Textbooks were written for the express purpose of filling the needs of the schools for temperance teaching, and many texts were reorganized, and included in their prefaces statements of their adaptation to temperance legislation.

The preface of the 1883 edition of Martin's *Human Body* contained the following statement: "The second edition of this book differs from the first . . . and deals in some detail with the important question of the influence of alcohol and various narcotics on health." In the preface of the fourth edition of another text (1884), the same author makes the following acknowledgement of the influence of the Women's Christian Temperance Union: "This edition has been revised in accordance with the wishes of the Committee of the Women's Christian Temperance Union in Maryland, who now endorse and recommend the book." Another textbook, Steele's *Hygienic Physiology* (1889) printed with pride a full page endorsement by Mary H. Hunt, leader of the temperance forces.

Unfortunately, many textbook authors, in their efforts to comply with Women's Christian Temperance Union demands, included material with no scientific backing. The evils of alcohol and tobacco were frequently exaggerated. (A good example is the excerpt from Steele's book given in the discussion of physiology teaching in Section II.)

Physiology, as a secondary school subject at least, has largely been absorbed by general biology courses. Whether these courses really include much of the temperance teaching required by legislation would be hard to ascertain. Fay (1930, p. 448), in his survey of the Women's Christian Temperance Union influences, expresses doubt:

> It seems probable that many teachers of physiology and hygiene have omitted "scientific temperance" from their courses, or have treated it superficially. And it is certain that the higher institutions of learning have been apathetic toward the question.

He quotes (p. 449) from the demand of Dr. Clarence True Wilson for continued enforcement of the laws in 1929 that "Our public schools must be made to reinaugurate their scientific temperance instruction upon alcoholic liquors, narcotics, and opiates." And from the report of the Genessee Annual Conference of the Methodist Episcopal Church in 1928:

> We insist that the educational authorities of the States in which our Conference lies carry into full effect the statutes that enjoin the teaching of the effects of alcohol and other narcotics on the human body, both as regards the contents of the textbooks and the fidelity of the teachers.

Legislation

Legislative action in making compulsory the exclusion of the theory of evolution and the inclusion of temperance education in biology teaching has been mentioned. In addition, some state legislatures have curtailed laboratory teaching by prohibiting vivisection and other types of animal experimentation. Section 33 of such a statute enacted by the Massachusetts Legislature in 1920 reads as follows:

> No person shall, in the presence of a pupil in any public school, practice vivisection, or exhibit a vivisected animal. Dissection of dead animals or any portions thereof in such schools shall be confined to the classrooms and to the presence of pupils engaged in the study to be promoted thereby, and shall in no case be for the purpose of exhibition. Violation of this section shall be punished by a fine of not less than ten nor more than fifty dollars.

In a thesis dealing with the legal restrictions on biology teaching, Norval Adams (1930, pp. 13-14) devotes a chapter to laws on animal experimentation and quotes from a number. Some of these citations, showing the tendency in legislation, follow:

> Experiments on any living creature shall not be permitted in any public or private school of this state (Alabama Statutes, 1924).
>
> No experiment upon live animals, to demonstrate facts in physiology, shall be permitted in any school of this state (South Dakota Statutes, 1929).
>
> No experiment upon any living creature for the purpose of demonstration in any study shall be made in any public school of the state. No animal provided by nor killed in the presence of any pupil in any public school, shall be used for dissection in any school, and in no case shall dogs or cats be killed for such purposes. Dissection of dead animals, or any parts thereof, shall be confined to the classroom and shall not be practiced in the presence of any pupil not engaged in the study to be illustrated thereby (Illinois Statutes, 1928).

It is apparent that in states where such laws exist, biology teachers would be handicapped in methods by the prohibition of several interesting demonstrations and experiments, such as those on nutrition.

Another form of legislation affecting biology teaching is that requiring the teaching of biology in the schools. All the states now allow biology teaching and four states, Minnesota, North Carolina, South Carolina, and West Virginia, require it. It is recognized as a laboratory science, since regulations provide for double periods (Adams, 1930, pp. 61-62).

Recent legislation in many states, making courses in *Health* compulsory, has affected the content and aims of general biology courses in that the health aim no longer needs to be given so much emphasis in the general biology course.

Influential Committees

Although the degree to which reports of the National Education Association committees have affected high school biology may be an uncertain point, there is no doubt that they have exerted definite influence. The first important one, that of the Committee of Ten, published in 1894, offered detailed recommendations, of which the following is an excerpt:

> Resolved, that it is the judgment of the conference that while the principles of hygiene should be included in the work of the lower grades, the study of physiology as a science may best be pursued in the latter years of the high school course. We recommend that in the high school a daily period, for one year, be devoted to the study of anatomy, physiology and hygiene with as large an amount of practical work as is possible.
>
> That the study of natural history (botany and zoology) should begin in the primary schools at the beginning of the school course.
>
> That a minimum of one year's study of natural history should be required in every course in the high school, and that at least three-fifths of the time should be employed in laboratory work.
>
> That the general comparative morphology of physiology and anatomy be recommended as part of the natural history most suitable for study in the secondary schools; that in the primary and grammar grades there should be a study of gross anatomy, and in the secondary schools a study of minute anatomy.
>
> That the year's work in natural history, as outlined for the high school, should be required for entrance to college in every course; that the examination should be both a written test and a laboratory test, and that the laboratory notebooks, covering the year's work, certified by the teacher as original should be required at the examination.
>
> That the study of natural history in both the elementary and the high school should be by direct observational study with the specimens in the hands of the pupil, and that in the work below the high school no textbooks be used.
>
> That at least one-fourth of the high school course be devoted to nature studies; and that this amount of preparation should be required for entrance to college.

N. J. Harris, commissioner of education at that time, considered this one of the most important documents ever issued in the United States, but later studies as to the actual adoption of its recommendations revealed its lack of extensive influence. Dexter (1906, p. 264) made a study of the extent to which the recommendation for separate courses in botany and zoology was followed, by analyzing all possible courses of study, eighty for 1894, and one hundred sixty for 1904, with the results indicated in Table 10.

It is apparent that this recommendation, at least, was disregarded. Concerning the recommendation about physiology, Dexter observed that there had been a decrease of schools offering it. By 1904, as previously noted, the reaction against the "general morphology of physiology and anatomy" had set in. Altogether, the Committee of Ten report would seem to have fallen short of making the imprint predicted for it. Inglis (1918, pp. 665-666) listed the following reasons for the failure of its biological suggestions:

2. The obvious dominance of the college-admission function.
3. The differentiation of curriculums on the basis of predominating subjects rather than on the basis of the activities of life to which pupils will apply their training.
5. The failure to provide for those pupils who must leave school before the secondary school course can be completed.
6. The relatively small amount of flexibility afforded.
7. The failure in other ways to provide curriculums well suited to the demands of individual differences.

The Committee of Sixty in 1898 offered recommendations which in part were later incorporated in biology teaching, whether as a direct result, or as the result of conditions which the committee recognized and provided for. The recommendations were, briefly: (1) No science should be offered for less than a year, (2) Colleges should require uniformity in high school science, (3) Biology should interest the pupil whether a college candidate or not, and (4) Anatomy of plants and animals is out of place in the school course.

TABLE 10. *The influence of the recommendations of the Committee of Ten on biology courses taught*

Name of Course	Percentage of Schools Offering	
	1894	1904
Botany	48	30
Zoology	9	6
Botany and zoology	43	64

The Committee on College Entrance Requirements (Nightingale and Committee) at the end of the century (1899) suggested a sequence of science subjects placing biology in the second year, and subsequent studies of biology placement have shown that biology has from the first been placed largely in the second year.

A most influential committee report of the National Education Association was undoubtedly that of the Science Committee of the Commission on the Reorganization of Secondary Education, published in 1920 after seven year's work. Hunter says of it (1934, pp. 116-117) that ". . . a monumental bulletin was issued in 1920 as a report of the Commission on the Reorganization of Secondary Education, appointed by the National Education Association. This report . . . suggests a sequence of science which has been fairly widely adopted, according to findings of the writer." The science sequence outlined by the report placed biology in the ninth grade in junior-senior high schools, and in the tenth grade in regular four-year high schools.

The statement of objectives of the committee, probably the most influential definition of aims for science in recent years, corresponded with the "cardinal principles" of the entire commission, and in addition it listed the following values derived specifically from science study: (1) the development of many and varied interests, habits, abilities, (2) development of direct, effective, and satisfactory methods of solving problems, (3) stimulation of the pupil to more direct and purposeful activities, (4) building up of an intelligent understanding of the conditions, institutions, demands and opportunities of modern life, and (5) development of cultural and aesthetic values. No definite determination of the extent to which these aims have been utilized in practice has been made, but recent trends indicate teaching for better equipment with which to solve life problems. A conference of high school teachers meeting in Illinois about this time formulated much the same set of objectives.

The suggestion of the committee for the use of biographical material has been met by most recent textbooks. The committee deplored the continued misuse of the laboratory and approved the departure in favor of the study of living forms. It insisted, however, that biology could function most adequately only if presented in relation to human welfare.

The humanizing of biology in recent years has been noted. It is true that the trend toward humanizing biology existed before the committee report. This committee was different from earlier ones in that it was not radical in its recommendations but summarized the best of the existent practices. Their procedure was outlined in the preface (p. 10) as follows:

> The committee on science of the Commission on the Reorganization of Secondary Education has carried on its work by means of discussions, correspondence and formulations of preliminary reports for over seven years. The discussion of preliminary reports by groups, committees, and at meetings of science teachers have revealed progressive work already under way and have led to the trial of preliminary recommendations. Some of the improvements that the committee sought to effect have already been adopted by many of the best schools. The full report herein presented formulated through this procedure, incorporates practices that have proved most useful. It asks for only those features of reorganization that have been found to work well, or which by a fair amount of trial, promise improvements.

One reason ascribed for the greater practicality of the suggestions of this committee as compared with earlier reports was the difference in personnel between the 1920 committee and previous committees, such as the Committee of Ten. Whereas the Committee of Ten had consisted of five college or university men, three high school men, one teacher from a normal school, and one superintendent; the committee making its report in 1920 consisted to a larger degree of high school teachers or administrators, there being twenty-four of them, eleven college or university men, six from normal schools, five superintendents of schools, and one in commercial work. The greater number of high school educators no doubt had much to do with the more conservative nature of the recommendations made. Recent studies would also seem to indicate a greater acceptance of the recommendations than the studies for the earlier report indicated. A study of teacher-emphasis on subject material (made by Hunter for 1908 and 1923, and tabulated by Fay, 1930, p. 394) is reproduced in Table 11. This table shows that less emphasis was placed on taxonomy, morphology, ecology, and human physiology in 1923 than in 1908, while human biology and relations to man had made spectacular gains, and health, not taught enough to be included in the earlier questionnaire, occupied the leading place in 1923 (after the committee report).

TABLE 11

Number and per cent of high school teachers of biology emphasizing certain phases of the science in 1908 and 1923
(*As tabulated by Fay*)

Phase Emphasized	1908		1923	
	No.	%	No.	%
Taxonomy	27	10%	19	5%
Natural History	76	28	106	29
Morphology	139	50	106	29
Ecology	136	49	114	31
Human Biology	55	20	216	59
Human Physiology	178	65	226	61
Relations to Man	138	50	257	70
Health	--------	----	261	71
Teachers answering questionnaire	276		368	

In 1927, a list of objectives similar to that prepared by the 1920 committee was suggested by the Committee on Standards for Reorganization of Secondary School Curricula of the North Central Association, one difference being a division into four ultimate and four immediate objectives.

The Thirty-First Yearbook, published by the Committee on the Teaching of Science of the National Society for the Study of Education in 1932, also exerted influence on teachers. However, perhaps, since its suggestions were less of a departure from existing procedures, its influence was less than was that of the National Education Association committee report of 1920. Hunder (1934, p. 118), in discussing its importance, criticized it because it based ideas on only one school of psychology; because, attempting a continuous program based on *big ideas* by the use of thirty-eight generalizations as objectives, it offered no application to the child's life, health, or citizenship; and because intellectual objectives were dominant. As positive contributions, Hunter listed its suggestion for a unified program, and its emphasis on the scientific attitude.

In addition to the major national committees, many state organizations, such as the Board of Regents of New York, and many teachers associations and city committees on biology reorganization, have had their own definite, though limited, influences upon the teaching of biology.

The European Influence

Biology was introduced from England, where, as a combined botany and zoology course, it was first taught by Huxley. Huxley's views on high school and college biology have already been cited (See Section II). The first biology course in America was a college course taught at Johns Hopkins University by H. N. Martin, a former pupil and assistant of Huxley. Whitney (1930, p. 149) described the influence of this course on one of the first high school biology courses, that introduced into Chicago in 1892, as follows:

> Professor Martin of Johns Hopkins University was giving one of the first courses in biology given in this country, if not the very first. His course was copied after Huxley whose pupil and assistant he had been. The course consisted of lectures on a series, in evolutionary order, of types of animals and plants representing the principal and most important groups. Laboratory work accompanied these lectures which were very exhaustive but gave little attention to related forms of animals or plants. . . . As in the case of the equipment of laboratories Mr. Boyer planned the course of study (for the high schools) for biology essentially after the Huxley and Martin course.

High school biology thus came rather directly from England. In addition to the influence of Huxley, several writers on the history of biology indicated that the new course was given considerable impetus by another Englishman, Darwin. Nelson (1931, p. 7) states that

> The general biology course was further strengthened by Darwin's dissemination of the evolutionary doctrine, which, while strongly opposed by Agassiz during his lifetime, received considerable attention in biology courses soon after his death. Evolution then served as the unifying principle in the study of biology.

The theory of evolution undoubtedly was an important factor in the development of the type method of laboratory study. The laboratory method itself was new at that time and was another European contribution to biology. Frank (1926, p. 10) gives the following explanation of the introduction of the laboratory method into American science courses:

> About this time (about 1880) students who had been in the German universities began to return to America to teach in the colleges and better high schools where they introduced the laboratory method which had been made popular by Liebig, Helmholz, and others in Germany.

'he most potent force in the introduction of laboratory work into erican biology courses was that of Agassiz, Swiss scientist, who ught European methods to America and remained to saturate the ege system with his enthusiasm for laboratory work and even to uence the secondary schools.

Caldwell (1935) ascribed a further change in science to European luence:

> American biologists turned to European teachers and research men for education and guidance. They and their first students soon established in America not only the laboratory as an instructional essential, but they brought also the idea of high specialization. Thus instead of college teachers of botany, we came to have teachers of morphology or physiology or ecology or cytology. These specialties also appeared in secondary schools.

Much of the foundation of psychology that later was so important factor in the trend away from specialization in secondary school iology, came from Europe, however, and creditably offset the bad nfluence of the earlier principle.

Psychological Discoveries

"Advances in educational psychology have brought marked changes in our views regarding objectives and methods of teaching," wrote Frank in 1926. Certainly there is a wide variance between present objectives and the mental discipline aim that dominated biology at its beginning in America.

When biology was introduced into American schools, faculty psychology, with its implications concerning transfer of training, dominated educational procedure. The mental discipline aim was the aim of the period, and, in many cases, if we are to judge from the predominance of the thorough-going laboratory study of types, it was the only apparent major objective.

The validity of the theory of mental discipline was questioned by the protagonists of a new school of psychology, the functional, or physiological school. James, first and most outstanding of American psychologists, did the earliest work on transfer of training, but he himself admitted that his experiments were inaccurate. The first real attack on the mental discipline doctrine was the experiment of Thorndike and Woodworth, who in 1901 announced the following conclusion: "Development in any single mental function rarely brings about improvement in any other function, no matter how similar, for the working of every mental function group is conditioned by the nature of the data in each particular case."

There were other factors in the discontinuance of the type method, but experimental proof against the objective backing it undoubtedly played a worthy part. In their text on biology teaching, Lloyd and Bigelow (1914, p. 260) acknowledged the influence of psychological findings thus:

In the decade since this chapter was written there is a decided tendency toward emphasizing information rather than discipline as the chief educational value of zoology, and indeed of natural sciences in general. The psychological investigations concerning formal discipline have indicated that probably there is no peculiar mental discipline in the method of study of a given science.

The men who revived the theories of Herbart and had helped in the overthrow of the mental discipline doctrine, contributed to the foundation of new objectives and methods. Herbart had early recognized the importance of interest, and he had formulated a theory of apperception which later psychologists, notably Judd, verified and applied to education. The influence of this doctrine is readily recognized in the following statement from a recent biology textbook (Hunter, 1931, p. v): "The unit is introduced by a number of survey questions intended . . . to give the teacher an opportunity to find out what 'apperceptive mass' exists in the minds of the pupils."

The return to a study of living things and the development of the problem method depended in part on this doctrine. Cole, in his textbook on teaching, wrote (1934, p. 56) that "Biology teaching can be vitalized and taken out of the abstract largely through correlating it through illustration and application with the information the pupil already has, and with the problems and materials of the environment with which he has some degree of familiarity."

The Herbartian Five Steps in the Learning Process, much the same as those Dewey formulated for problem-solving in his book *How We Think* (1911) were important in the early development of the problem method. Since these formulae for learning required that the pupil be made interested in the problem, the learning situation was essentially a teacher-centered one. Recent trends, as we have shown, are toward pupil-centered learning. This tendency may be traced to later work of the physiological psychologists, especially the Behaviorists led by Watson, who opposed the formal five steps, insisting that it was necessary to start from the pupil's experiences and interests—the theory of apperception again. They also emphasized the importance of emotions in education, giving further support to the doctrine of interest.

That the doctrine of interest is considered important by biology educators is attested by the numerous recent studies made on interests in biology. Hunter's book, *Science Teaching* (1934), offers a comprehensive discussion of at least fifteen such studies. The emphasis on interest is also quite apparent in the organization of textbooks and the inclusion of such material as leisure time activities. Emotions are given place in the development of modern objectives in the appreciational aims which are increasing in importance.

The Gestalt psychologists, of the physiological psychology school, with the idea of the combination of environmental stimuli and internal stimuli to produce tension, gave impetus to the interest in motivation which is so important in modern teaching.

The experimental method developed by psychologists is being used more in the testing of old ways of teaching and the development of new, as witness the two recent books by Curtis (1926, 1931) which review two hundred seven research studies on problems of science teaching.

Many science teaching experiments have been concerned with the development of the scientific method or attitude, and the crux of the scientific attitude problem is the question as to whether there is any transfer of training, and if there is, how much and how obtained. This was a question by no means settled by the investigators in the early years of the twentieth century. Orata (1935) made a survey of transfer of training studies, finding that there had been 167 objective studies from 1890 to 1935; 99 from 1890-1927, and 68 from 1927-1935. Of all these studies he wrote (pp. 266-267, p. 276) that, "If the results of all studies from 1890 to 1935 are put together, assuming that they possess a fair degree of validity and reliability, we may, with confidence make the following generalization: 47 or nearly 30% show *considerable transfer,* 80 or nearly 50% show *appreciable transfer,* 15 or less than 10% show *little transfer,* 6 or less than 4% show *no transfer,* and the rest which comprise less than 10% show both *transference* and *interference*. . . .

"The fact of transfer can no longer be doubted, but it is not an automatic process. . . . It is something to be worked for directly."

He also analyzed these studies for the most effective methods for transfer suggested, with the following results: 70 per cent of the studies support practice in generalizations as most effective—a theory propounded by Judd—and about 30 per cent support the idea that practice is specific and that transfer may best be obtained when there are identical elements—Thorndike's theory.

Lehman (1933, pp. 81-82) was one of the recent investigators who found that the identical element hypothesis did not hold. He reported of his study that

> It reveals clearly that the *existence of identical elements is of itself no guarantee that transfer will take place.*
>
> . . . It *should* enable the student to understand why discrete teachers are more likely to employ the potential than the indicative mode when discussing the transfer of training. Transfer *may* (*and it may not!*) occur.

Woodrow (1927) experimented with types of training for transfer by using three groups: one was a control group, one a group receiving routine drill, and one a group receiving drill in the same material but with definite instruction in memorization technique. The percentage of gain in the end-tests averaged 31.6 higher for the training group than for the control group, while the group receiving only drill did not score so well. He drew the following conclusions:

> In short, the experiment shows that in a case where one kind of training —undirected drill—produces amounts of transference which are sometimes positive and sometimes negative, but always small, another kind of training

with the same drill material may result in a transference, the effects of which are uniformly large and positive.

Since transfer of training by experimentation proved a possibility, the scientific attitude may be considered a safe objective for biology, and since conscious development of generalizations seems to be effective in obtaining transfer, educators in biology may be encouraged to continue experimenting with this method.

College Dominance

Colleges have influenced, and continue to influence, the biology of secondary schools in two ways: (1) through the direct effects of their training for teachers, and (2) through their requirements for admission.

Biology as a college subject was imported from Europe, and early American biologists turned anxious eyes toward the European universities for the proper methods of teaching the new subject. Agassiz, himself a Swiss naturalist who remained in America after 1842 as a professor at Harvard College, was undoubtedly the most eminent of science professors whose college biology method extended to the high schools. Fay (1930, pp. 266, 299) wrote of his influence:

> Agassiz's emphasis upon structure, although more fruitful at the time than classification, was a means toward the subjection of zoology to the disciplinary craze. Untold thousands of high school pupils have dutifully carved up dead frogs and grasshoppers and have laboriously drawn the various organs of these animals. For this Louis Agassiz may be held partly responsible. His insistence upon careful observation was assuredly a progressive step. But too many teachers have imitated his technique without sharing his spirit; the result has been to an unfortunate extent a rigid formalism. . . .
>
> . . . And through the Harvard summer schools, teacher's institutes, popular lectures and writings, textbooks, and other means, Agassiz managed more or less to get his idea across to zoology teachers in the secondary schools.

The way in which Mr. Boyer organized Biology courses in Chicago schools after Martin's college courses has been mentioned. Linville in 1910 wrote of the extension of college method to the secondary schools that, "The teachers of morphological biology in the schools brought with them from the colleges certain ideas of method. Possibly the lecture system never took strong hold in the schools, but the laboratory method of the college, with much of its paraphernalia, did. The consequence of this was that thousands of young untrained pupils were required to cut, section, examine, and draw the parts of the dead bodies of unknown and unheard-of animals and plants, and later to reproduce in examinations what they remembered of the facts they had seen."

Whitney complained in 1913 that "Even the laboratory tables were copies from the style found in college laboratories. In fact the entire course was modeled on the college course—simply a slightly modified edition of the college course. The tendency has been away from this hand-me-down college work toward something specifically suited for the high school needs, . . ."

The first decades of the twentieth century did indeed find a rising tide of discontent at college dominance of the secondary schools, for not only did the colleges superimpose their methods upon the secondary schools through teachers and textbooks, but by rigid entrance requirements had largely been able to determine the content and method of high school courses. Fay (1930, p. 316) states that,

> College domination was fostered by some state teachers' associations, by the policy of such state departments as that of New York, and by the influential committees of the National Educational Association.

Perhaps the most powerful influence in the history of college dominance was that of the Committee of Ten, which reported in 1892 on standard college entrance requirements. Although its suggestion of a minimum of one year of natural science was intended to include only botany and zoology, the methods demanded undoubtedly affected the teaching of biology as well. It recommended that the entrance examination place greatest emphasis on laboratory work and that laboratory notebooks by all means be required. Of the 220 hours required in zoology, 120 should be given to laboratory work. Type studies were advocated.

A committee on college entrance, appointed by the National Education Association and reporting in 1899, did much to determine the grade placement of biology. Its suggestion that all colleges require standard science courses was met in part by the organization of the College Entrance Board in 1900 to propose standards for biology and other subjects.

Frank (1926, pp. 10, 11) discussed the effects of the college domination of high schools and considered the first part of the period of dominance beneficial, but that later the influence had degenerative effects. His discussion follows:

> During the first part of this period of so-called "College domination," the high schools undoubtedly benefited. They began to have better teachers, their courses tended to become standardized, and the high school, as a school, acquired a decidedly enhanced reputation. But after a decade or so the effect of college domination was not so beneficial. College teachers were preparing high school science texts by rewriting in simplified and shortened form their college texts. . . . The science courses became denatured college courses, of value as introductory college courses because they were organized on that basis, but having little real value to those who would not go to college. . . . The whole effect of college domination of standards, simplified college texts and untrained teachers fresh from college instruction, was to produce a type of high school science of reduced value to the average high school pupil.
>
> As a result, high school science lost much of its former standing with the public.

Colleges frequently refused to accept biology as an entrance requirement in science. Some of the results of Kilander's study (1929, p.

NOTES ON MORTALITY OF FISH AT KEPHART PRONG FISH REARING POOLS

EDWIN B. POWERS

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It was reported to me from time to time by Mr. Willis King, Assistant Wildlife Technician of the Smoky Mountains National Park, that young fish placed in the growing pools at Kephart Prong died within twelve hours or so. At my request I was allowed, May 16, 1936, to precede a placement of small trout (fingerlings) from the Erwin, Tennessee, State Hatchery (about 5:30 A. M.), in one of the pools. I remained and made observations on the physical and chemical changes during the following twenty-four hours. Variations in the temperature of the air and water, the pH of the water unaerated and aerated (determined colorimetrically) and the oxygen content were all followed.

The pool examined was a circular cement structure, 25 feet in diameter and grading 18 to 30 inches in depth, with outlet at surface and inlet at top, just below full level at the side and directed at an angle downward. This arrangement caused the water to circulate in one direction around the pool.

The pool was empty the day before and was filled with running water the night before from an artificial pond about 3 feet deep, formed by constructing a dam across a small creek. The water was conducted through a 10-inch galvanized spiral welded steel pipe for a distance of about 1,000 feet before emptying into the pools. The water was allowed to stand all night. The inlet was opened again the next morning before the 500 or so fish were placed in the pool.

Table 1 gives data obtained from observations made during the twenty-four hours following the placing of the fish in the pool. The table also contains data taken of the water in the artificial pond—the source of the supply water for the pool containing the fish under observation as well as for the other pools. When the data are examined it is found that there are no striking differences in the two waters from the pool and the artificial pond except the differences in the pH of unaerated and aerated water and the slight increase in alkalinity in the pool water over that of the pond water. The higher alkalinity is indicated by the higher pH of the aerated pool water. Fish had always been carried successfully in the wooden troughs located at the supply pond when the water was taken directly from the pond. With few exceptions the fish had always died when placed in the growing pools supplied with water through the 1,000-foot pipe. Yet the differences in temperature and oxygen in no way approached the limit of tolerance of fish to either of these factors. As a matter

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