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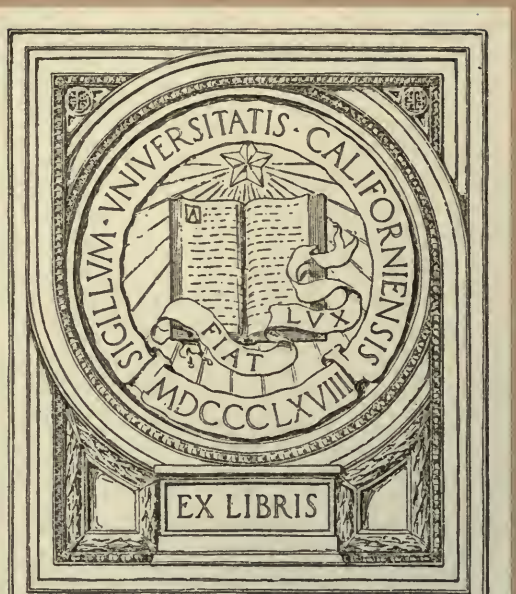

ADEQUATE PREPARATION FOR THE TEACHER OF BIOLOGICAL SCIENCES IN SECONDARY SCHOOLS.

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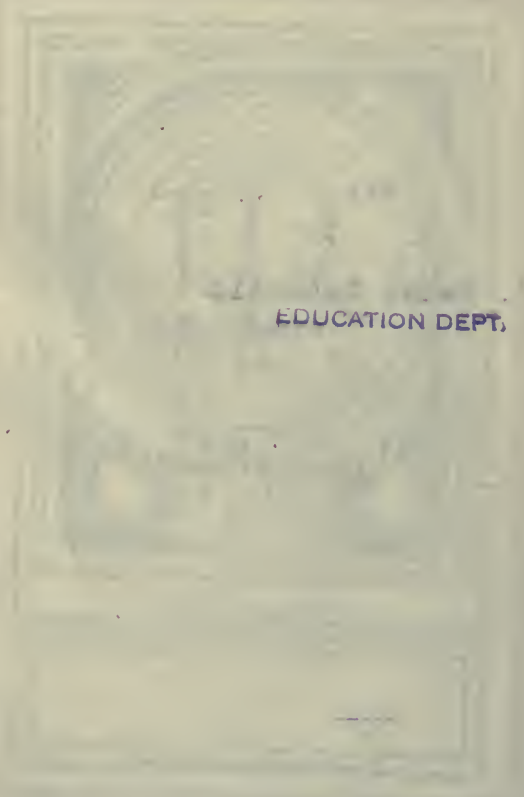

CONTENTS

The use of the term preparation herein is intended to indicate partially the limitation of the problem attempted. The following discussion will be concerned only with such attributes of the successful teacher as are the direct result, or at least greatly enhanced by thorough preparation. A sufficiently comprehensive and difficult problem remains after still further restriction of the field so as to include only subject matter and the method of biological science.

It is scarcely necessary to make the statement that the standards of preparation and the facilities for meeting these standards have been enormously improved within the past few years. Evidence of this is found in the changes recently made in the curricula of and the requirements for graduation from the California State Teachers Colleges. Neither is it necessary to say that improvement must continue. Such problems are evolutionary. Notwithstanding that requirements for teachers certificates have been raised the country over, the universities are not generally making very rapid strides in affording opportunities for better preparation in subject-matter and special methods. In corroboration, witness the recent criticisms of the departmental courses in special methods now given in universities generally (Swift, 1918; Taylor, 1918). The length of time or the number of units of work required for certification may be increased but that does not insure a finer quality of preparation.

In attempting to explain the slow pace of improvement in the quality of preparation for the teaching of science, one becomes involved in a cycle. Science had its development in the college and university whence it diffused slowly into the secondary schools, and finally slightly into the elementary grades. The differences between the aims of college science and secondary school science were and still are not taken sufficiently into account. As an inevitable result there are to be found in the curricula of high schools too many sciences, courses that are mere dilutions of the college type, with no modification of purpose, and just enough change in method and subject matter to bring them partially within the power of understanding of the less mature mind. This situation in turn reflected upon the higher institutions of learning in such a way that it seemed that they were giving adequate training of the correct type. And such would have been the case had the college course in the particular science been planned for the express purpose of being diluted to suit secondary school needs. But it will be generally conceded that such courses never have existed.

Another retarding factor in the evolution of the problem has been the subordination of special training in subject matter to other really less important qualifications, in the selection of teachers. The table given below, compiled from statistics gathered in one of the States during 1916, shows sufficient justification for the above statement. And not only has the

Subject	Prepared & teaching	Not prepared & teaching	Prepared and not teaching	Total
Physiology	19	8	57	84
Botany	71	39	74	184
Zoology	9	20	5	34
Agriculture	63	14	84	161

preparation in subject matter been too little considered in choosing teachers, but also in the administration of schools specially intended for teacher-training. An educator of high standing in California is credited with making the criticism of the Normal Schools of the State; that they attempt to teach a person how to teach intellegently something about which he knows nothing. When teachers have adequate preparation in subject matter as well as in methods, and when they are employed to teach only those subjects for which they are fitted, then the problem of maintaining a high standard of teaching will be well nigh solved.

Preparation in Subject Matter

Before facing the problem of preparation for the teaching of biological sciences in the secondary schools, there must be a clear conception of the aims and legitimate purposes of these sciences in the high school. We are fortunate in having the aims of biology clearly and concisely stated by the Commission on the Reorganization of Secondary Education of the N.E.A. ("Reorganization of Science in Secondary Schools", U.S.Dep't. Interior, Bureau of Education, Bulletin 26, 1920). These aims will not be considered in their entirety but only in so far as they bear directly on the

problems that follow. Before proceeding further, for simplificatio we will assume that the teacher is assigned to teach biological sciences only. Even then the field is quite comprehensive, for besides instruction in general biology, there will be courses of a more advanced type, in Zoology, Botany, Physiology, and often Bacteriology, Sanitation, or Agriculture. However, with preparation in the fundamentals necessary for biology a teacher should be able to conduct such courses without difficulty. Thus the problem is sufficiently inclusive if it concerns preparation for biology alone.

The brief literal translation of the word biology, science of life, is full explanation of its scope. A course in the subject is not Zoology, nor Botany, Nor Bacteriology, Nor Physiology - but rather all of these in one. Biology should logically follow the nature study of the elementary grades, The course must be so planned that it will give the pupils the maximum of serviceable fundamentals and at the same time be a basis for further study in advanced courses, if he desires to continue; but such that he will miss none of the essentials if he does not. Since science is the product of mature minds, the culmination of knowledge, then in this course for adolescents, the "ology" must not be too greatly stressed lest the essential part, the "bios" be obscured. The goal then is a course in which a study of plant life, a study of bacteria in relation to human welfare, a study of animal life, and the biology of the human, are all incorporated with well balanced emphasis. This is the type of course recommended by the Commission on Reorganization for the ninth or tenth year

pupils, so is the end toward which preparation should be made.

The next question concerns what constitutes adequate preparation for the direction of studies of animate nature. First and foremost is a realization of the aims, or better, the values, and relations of biology. It is a socializing subject and must be so taught - man is social. Biology affects man vitally, directly his behavior follows natural laws, and indirectly by illustration and comparison brings him to a better understanding biologic laws underlying the organization of society. By way of illustration we need only to cite the struggle for existence and the division of labor with their far reaching influence in determining the course of evolution. It would be impossible, I believe, to teach biology so poorly that it did not have some socializing value; but it comes very near to being done in some cases, there is little doubt.

A paramount aim is the improvement of living conditions, both as it concerns measures for group sanitation and factors in the health of the individual. This should be the almost exclusive aim in those parts of the course dealing with bacteria and disease, and the biology of man, or physiology and eugenics. Biology has many applications in our economic life. It is the very foundation of agriculture. The lumber industry is beginning to find that there are biologic laws. The Government of the United States some time ago established a Bureau of Fisheries for the purpose of studying the biological problems involved in the continuance and furtherance of our extensive fisheries industry.

So far as the individual is concerned, biology should train him to observe life phenomena accurately and to form logical con-

clusions , through the use of problems. This ability is a valuable asset whatever his life work may be. Also, if it is the right kind of a course, and well taught, it will enrich the life of the boy or girl through the aesthetic appeal of plants and animals, and so make possible a sincere appreciation and enjoyment of nature. In addition, the study of biology should make clear to the pupil the important part that the intensive study of the various biological sciences has played in the whole marvelous scientific progress of the past centuries.

Along with these values certain relations of biology must be well understood if it is to be well taught. These relations may be conveniently segregated into five groups, 1) relations to world problems, 2) to problems of the state, 3) to the community, 4) to the school curriculum, and 5) to individual pupils. To world problems biology bears many relations, for example, it is fundamental in the analysis of immigration problems, especially those phases concerning health, over-population, and the probable hereditary effects of assimilation through hybridization. State problems of health protection, conservation of game and forests, control of redents and other crop pests, and others can only be solved after gaining a thorough knowledge of the underlying natural laws, and acting in accordance with them. How inadequate a game conservation law of closed season, without regard to the breeding habits of the animal concerned! Again, State regulations regarding the care of mentally deficient, especially in the prevention of intermarriage, must be given consideration from the biologica

as well as the ethical point of view.

As we consider the smaller group unit so the relations of biology to that group become more special. A biology course may be readily standardized for national problems, but for any given community the course must be somewhat unique. A course planned for a rural population would not be fitted for a school in an overcrowded section of a city. Where there are differences in social and biological problems there also must be fitting adaptive changes in the course in biology. In addition to these community relations, the teacher must keep in mind the relations between the biology course and the other courses in the curriculum of the school. Such a question as this should arise in the mind of theteacher; how may my work be made to correlate with that of Domestic Science? The possibilities are many, there is the field of dietetics, scientific determination of the best methods of sweeping methods by basterial culture methods, and the role of bacteria, yeasts and molds in the culinary arts constitute a few of them. How about cooperation with the English Department? Certainly every bit of written work, every oral recitation, should measure up to standards of ability in expression as well as to standards of attainment in the mastery of certain scientifis information. This cooperation has been carried out to great mutual benefit in some schools. These illustrations are sufficient to illustrate, though the teacher should not overlook any department of the school.

Relations to class and to individual will be considered in conjunction with teaching methods.

The values and interrelations of biology have been discussed at

some length because they must serve as criteria in deciding what constitutes adequate preparation.

The comprehensiveness and vital nature of the subject, biology, present at once an inspiration and an element of fear to the conscientious teacher. They cause him to regard in utter amazement, the applicant for a position who in answer to question replies "No, I have never taken any courses in biological Science, but I can easily prepare myself to teach it, if need be!" The impossibility of such impromptu development of skill in the teaching of biology will become more apparent as we proceed.

Besides a full appreciation of the aims and relations of the subject, the teacher must be able to construct a course especially adapted in content to the peculiar needs of the particular community. This follows from what was said of relations in a previous paragraph. The development of such a course demands sufficient knowledge of economics and sociology to make possible a correct analysis of local conditions and so find what is required. The course to fulfill the requirements will necessarily be to some extent new, and just to such extent may the teacher feel something of the inspiration of the pioneer. Relative values must be established; emphasis must be properly placed - life of distant regions should not be taught except as local material may not be available to illustrate some very essential point, yet too often a carefully pickled grasshopper is transported from Florida to California, there to be dissected by some unfortunate high school lad. Not only must the larger divisions of the course be carefully balanced and tested for value, but each lesson must justify its induction into it. It is at this point that the relation to the individual is the chief criterion.

Each lesson of the series that makes up the course must justify its place by having some rather direct bearing upon the life of the individual pupil. The core of the lesson must be either the pupils problem or one in which his interest can be readily stimulated. Herein is the value of the project method of science teaching, the problem is sure to be of interest to the pupil since he himself chooses it. Other questions to which the lesson must give satisfactory answer are; Why this particular lesson, at all? What relation does it bear to the preceding and following lessons? Is it of real value to the pupil in his living? What biological phenomenon does it teach? Is it the best problem to illustrate that particular phenomenon? What generalizations and practical applications can the pupil make?

The organization of a course in biology which is fitted to the needs of a certain community, the conditions of a particular class of pupils, and to the needs of the individual pupils so far as possible, requires that the teacher have an extensive knowledge of the subject matter as a background freeing him from the necessity of dependence on a textbook. Anyway, a biology teacher conducting the right sort of a course, will see that the textbook is only an incidental, if used at all. A continuation of set assignments in most textbooks would would dampen the ardor of pupils generally. Besides, few localities have textbooks fitted to their specific needs. One that does have is New York City. In fact it has two, "Elementary Biology" by Peabody & Hunt, and "Civic Biology" by Hunter. These both have a large sale throughout the United States,

But, of course, in most localities they can be used only to furnish supplementary reading, since portions only will be adapted to the conditions of the restricted locality. The fundamental life processes are the same the world over, but varying environmental conditions necessitates a variation in emphasis, in application, and in the choice of problems which make up the course. If the teacher is well prepared in subject matter, there is little use for a laboratory manual except as it may suggest new methods and new experimental materials. Students of the high school age should never be compelled to follow a set laboratory outline with detailed instructions for procedure; it will kill every whit of initiative.. The teacher must be so prepared, then, that he is able to steer a free course, employing books for reference and supplementary reading almost exclusively. He will cause the student to realize that the books are the result of human effort and therefor not infallible, and that they must always take second place to first hand observation and experiment. The study of animate nature, with endless opportunity for observation and experiment on every hand,permits little excuse for such method as is illustrated by "Be prepared to recite on the next three pages in the book, tomorrow, and read experiment 37 so that you wont have to waste any time in getting started with the laboratory work".

Somewhere in the course of preparation the teacher must have obtained a thorough knowledge of laboratory apparatus and supplies. The selection of types of apparatus best fitted to the course, and the knowledge of where to buy are both necessary. Also judgement must be exercised in purchase for few are the places where funds are

adequate for the ideal equipment of a laboratory. The money value of every piece of apparatus must be balanced against its relative usefulness in the successful culmination of the course. Besides this there must be a knowledge of the various uses to which the available apparatus may be put. A great deal depends on the ingenuity of the teacher in the adaptation of even comparatively simple apparatus. In connection with the laboratory part (and this should be the major part) of the course, there arises the question of field work and excursions. Laboratory is at best merely a substitute for the great out-of-doors, so the more work that can be done in the field the better. Aside from exploration to discover what parts of the particular locality will yield the largest fund of valuable biological information, the problem here is mainly one of method.

The teacher to be at his best must be somewhat of a naturalist. Upon his fund of interesting stories about the animals and plants that the children all know, will depend very largely the appeal of the work to the pupil. Somehting of the spirit that distinguished John Muir as the great naturalist is an inestimable asset to the teacher. If it is not among his natal blessings, he need not be completely discouraged for it can be acquired to some degree at least. Besides the advantage just mentioned, the fauna and flora must be sufficiently well known so that choice is possible for laboratory experiment and illustrative purposes.

In order to present any subject well, its historical aspect enters into consideration. The influence of individuals, of governments, of religion, and of the social ideals have all had their share in determining the present status of the subject. Science as it now is, is the result of growth, it has undergone

evolution, and is at present evolving. This will be thoroughly understood by the teacher of science, and this understanding will determine in part the method of presentation. In the history of the development of science there are many men well worthy of hero worship. It is hard to find more inspirational characters than those of Pasteur, and Lazear; men who devoted (in latter instance, sacrificed life) their lives to service for humanity. I n the life and work of Charles Darwin we find a splendid example of painstaking search for the truth. The records of the rocks, (Paleontology, the nature-written history of biology) will often come to the rescue of the teacher in clearing up the presentation of the difficult problems of evolution. The historic attitude must be "put over" to the pupil too, for he must know his world as the result of the evolutionary process, and as still in the process of evolution.

Even at the risk of adverse criticism I desire to include among the qualifications of a good teacher the spirit of research. This spirit can be acquired by specialization in one of the fields of biological science, followed by some actual research work.

Research in science is fundamental. It has three aims or ends, 1) discovery of facts thus increasing the sum total of knowledge. This is science for science sake. 2) Individual development. And, 3) Social service. These last two aims are most important to the teacher. So, his problem for investigation should have some practical bearing, and should be of his own choosing, not pointedly suggested by the professor in charge as is too often the case. If the research-student is given a problem which is some minor part of a larger problem being investigated by his professor it will preclude the very thing the prospective teacher

needs, namely practice in recognizing, analyzing, and solving a problem in its entirety and solely on his own resources. Being a mere helper is probably not the best way to secure such ability. Investigation may be broadening and developing to the individual or it may prove to be quite the reverse, but that lies within the control of the individual. Research for the teacher must emphasize equally actual additions to knowledge and personal attitude. It must not be an end in itself but a means to an end. The attitude of the investigator is essential to the understanding of children for the child is first of all an investigator. His questions, "what? why? how? when?" prove this beyond doubt. What is this but a search for truth, causal factors, and interrelations? Education uses this wholesome curiosity as a foundation principle, so the teacher must exhibit a sympathetic understanding of this universal attribute of children. No better summary of a discussion of the values of research can be found for our purposes than that by G. W. A. Luckey. It follows.

> "In order that teaching may be intelligent and in harmony with the laws of nature there must be a deeper and clearer knowledge of human growth and development. The teacher must know the nature of the individual to be taught and the ends to be reached in proper nurture. This can not be gained through the study of books alone, but may come through properly directed research in the workshop of life."

One of the aims of present day education is "to develop a man, the best man possible under the conditions; to assist nature through nurture; to enable the individual to find himself and to evolve naturally and rapidly to the highest levels and

even to rise above them. According to this conception . . . . . the initiaitve must come from within. The aim of the teacher should be to develop a self-sustaining, self-directing, altruistic individual keenly alive to the interests of humanity. Such an ideal is progressive, scientific, and fits one through studies of yesterday and today to live the best and truest life tomorrow. To see and appreciate this ideal, research is necessary."

The last requirement to be considered in this discussion, is a good foundation in Physics and Chemistry. Biological science is not entirely separable from physical science, for a majority of life phenomena, in final analysis can be explained only in terms of physical science. Physiology has for its very foundation Physics and Chemistry. Among the newest of the sciences is Biochemistry, the chemistry of life; and within its limits are some of the most promising fields of research. No argument is necessary, a knowledge of physical science is indispensable in the interpretation of life phenomena, and the understanding of biological processes.

PREPARATION in METHODS

Method is more closely associated with personality and with native ability than is subject matter. So much more must preparation in this field be general in nature. It must mainly concern the general principles of the scientific method. Specific problems and minor details will have to be worked out in actual practice. The final method found most satisfactory by any teacher, will be to some extent unique, but will be largely determined by three factors; the aptitudes of the teacher, himself, the group that he is teaching,

and lastly, the consideration of the individual pupil. Ability to adapt ones procedure so as to most nearly meet these requirements, will come about only through experience. Abilty to profit by experience, the human attribute which makes possible the progress of civilization, is a no less valuable asset to a teacher than to any other member of society.

Balliet points out that science teaching has passed through three stages in the past generation. The first stage is characterized by the textbook method, occasionally supplemented by illustrative experiment, performed by the teacher. The second stage is characterized by individual laboratory experiment, a manual for a guide, and by a lack of application of the principles except for a few traditional cases. The third stage improves upon the second by leading the pupil, after formulating his generalizations, to apply them to the facts and phenomena of nature. "But," continues Baillet, "we must advance to a fourth stage. We must not only apply the generalizations, but make the explanation of the facts and phenomena of nature - the interpretation of nature - the very goal of science teaching." All problems should be chosen then in the light of this last aim. The problems must be natural, not in any way artificial, and they should be those of the immediate environment of the pupil. To meet these obligations may be in some cases difficult, but it should not be impossible.

In biological science there is a rich field permitting a considerable choice in method. There are observations, projects, experiments, excursions, individual reports, book readings, quizzes, and conferences. In a single well chosen problem or project nearly all of these will be employed. Biology lends itself ideally to the problem method of teaching. By using some every day problem

of the pupil, his interest is assured. Even a seemingly simple problem if skilfully directed, will ramify into several fields of biology before its solution is completed. And the number of practicable problems is almost limitless, but not all are equally good for the purpose, so the teacher must often tactfully modify the pupils choice. Original choices are likely to be too complex for the pupil to solve at his stage of progress, so must be simplified, without his feeling that he has been interfered with, without causing a wane in his interest. It is clear that the real problem in the problem-method is the teacher's. Practically, it is quite impossible to handle individual projects in large classes. In the writer's experience, he has had on the average 80 different pupils per day in four separate classes. It is clearly beyond the power of any teacher to direct simultaneously eighty different projects, and it would be a physical impossibility to furnish the necessary laboratory apparatus. So, for this reason the teacher may find it necessary to divide, as diplomatically as possible, the classes into congenial groups, each with its problem, so that the total number of problems will be so limited that each one may be given adequate attention. It seems that such must be the limitation of the problem-method under the conditions prevailing in the public schools today.

The procedure in solving a problem will consist of these steps in the order named, 1) understanding of the purpose, 2) the procedure or method of attack, 3) observation of results, 4) and the use of these in making some generalizations or arriving at some conclusions. Then there must follow a testing of these generalizations or conclusions by further experimentation. Accuracy must be the keynote of all work, accuracy in recording experiments,

accuracy in observation, accuracy in drawing, which serves as a shortcut method of description. Neatness is very desireable but should never supercede thinking and understanding. If the problem has stimulated some accurate logical thinking on the part of the pupil, then time spent on it has been well spent. If, besides, it has yielded some valuable useable information, the solving of the problem has been a marked success. The laboratory method has been such an emancipation from the textbook slavery that there is some tendency to elevate it to an end in itself, whereas it must serve only as a very valuable means to an end. "The ideal laboratory is only a reasonably good substitute for the out-of-doors."

So far as preparation in the methods of science teaching is concerned, much good may be accomplished in teachers courses and in practice teaching. But it must necessarily be of a general nature, for the unique individual method, determined by the interaction of teacher and pupil and the reaction of both to subject matter can evolve only hand in hand with teaching experience.

Before proceeding further it might be well, by way of summary, to remind ourselves that the minimum qualifications for a teacher of biology must include the following; a) a large fund of the most interesting and most valuable facts of biology, b) a full realization of the values and vital relations of biology to humanity, c) ability to develop a course meeting the unique needs of the community, d) familiarity with purchase and useability of laboratory equipment, e) knowledge of the history of science, f) spirit of and sympathy with research, g) a knowledge of physical science as related to biology, h) and knowledge of the laboratory method and its value in the promotion of accurate logical constructive thinking.

OPPORTUNITY FOR ADEQUATE PREPARATION.

What possibilities of making adequate preparation, are to be found in colleges and universities? And how much preparation is required by the Teacher's Recommendation or other standards of fitness? In search of the answers to our questions, we may study conditions at the University of California, for there is as good opportunity and standards are as high in this school as anywhere in the country. The quantity of preparation is fairly assured by the five-year requirement for the Teacher's Recommendation, but the quality of the preparation is not so certainly assured. With the possible exception of the Education Department, no department considers the training of teachers even nearly equal in importance to the production of specialists in the subject who shall devote their lives to research. The subject is regarded as an end in itself.

If a person were directed to make preparation for the teaching of biology, he would be at a loss in searching for the Biology Department, or even a department that gave a good comprehensive course in biology. The subject as best taught in the secondary schools is subdivided into various components, each with its special aim. The prospective teacher has no carefully prepared course of study for his pursuit, as has the prospective doctor, engineer, or farmer. The state provides a specially adapted course of training for its veterinarians, those who care for its livestock. Why not a special course of high standard for those who plan to devote their lives to the direction of the formative years of its children? It is probably explained in large part by the failure to recognize

teaching as a profession. The Schools of Education throughout the country have been insisting upon real professional training for teachers but other departments are deplorably slow in cooperating.

Inorder to avoid becoming entangled in abstractions, we may choose a specific instance to show the difficulties in the way of securing the correct kind of preparation, even though the quantity is guaranteed. The Zoology Department (I choose this department neither because it is worse nor better than any other, but because I am better acquainted with the content of its courses) makes the following requirements for the Teacher's Recommendation:

General Zoology
Invertebrate Zoology - an advanced course which omits all consideration of insects, and all discussion of parasitic forms.
Vertebrate Zoology - mainly a course in comparative morphology, which gives no field knowledge of California vertebrates, the most essential thing for the high school teacher.

and one subject from each of the following groups,

Group I
Comparative Anatomy.
Cytology - basic principles must be understood by the teacher but he should not have to spend one whole half year to acquire them.
Embryology.- the above is also true for this course.

Group II.
Biology of Water Supplies - this course is primarily for sanitary engineers.
Protozoology - All that is necessary of this could be incorporated in a general course.
Parasitology - essential for health instruction and for illustration of certain biological principles.

Group III.
Experimental Zoology
Animal Behavior } combination of these valuable.
Heredity, Evolution, and Eugenics - this course is very essential for any teacher.

(Required in the fifth year, the Teachers' Course, some work in research, and practice teaching.)

Taken as a whole, the chief criticism to be made is that the subject has been so subdivided to insure no overlapping of courses, that it becomes necessary to take every course in order to obtain a well rounded preparation in the field. This requires more time than any individual can devote to it, for he must also have preparation in Botany, Physiology, and Bacteriology and Hygiene, and in these departments the arrangement of courses is essentially the same. The general course in Zoology is inadequate, for it is planned for an introduction to the more advanced courses and is careful not to steal too much from their fund of interesting information. The aim is to lay a thorough foundation rather than to discuss the more interesting facts and general principles of biology, though I am glad to believe that the present trend is decidedly in this latter direction.

Here we find adequate preparation for a teacher of Zoology, but in no secondary school of the state will a teacher be employed for Zoology alone. In high schools the biological science curriculum the first course must be Biology, and it must be all-inclusive, for it is all of the biological science that the majority of the pupils will take. It would be a great step in advance if every school required even that much for graduation.

Of the courses in Invertebrate Zoology and Vertebrate Zoology, it can be safely said that they overlook the importance of field work. Boys and girls sometimes have a surprisingly large superficial knowledge of the plants and animals of their vicinity, and this knowledge is of the sort obtained through observation of their ways in nature, that is, it is a field knowledge. The teacher must be prepared to use this to the greatest possible extent, but how can this be expect-

ed if the teacher knows little if any more than the children about the habits of plants and animals. Such training would have to be obtained through some of the field work of the Museum of Vertebrate zoology. But no work in that department is required for the Teachers Recommendation. A knowledge, though not an intensive knowledge, of each of the subjects that make up the three groups included in the requirements is quite necessary but it is out of the question for a person to take them all unless he specialize in Zoology. Not all can be expected to major in Zoology, and those that do will find it necessary to omit much that is essential in the other departments of biological science. Each department should have a general course covering fully its field of work so that those majoring in some other department may in minimum time gain a fair knowledge of ~~the~~ its field ~~of Zoology~~. It is very doubtful if such a course is given in any department at present.

At present only a meagre view is had of the history of Biology, until the fifth year when it is given as seminar work. And at no time, in any course, are the aims and relations of biology presented in such a way as to be helpful to one attempting to plan the most valuable type of high school course. Graduate research has been sufficiently considered previously, and the teachers' course will be considered last.

It will be conceded generally in thinking of the solution of the problem that the ideal arrangement would be a real teachers' course, at least five years in length. This could be comparatively easily accomplished by a slight modification of the departments concerned and their hearty cooperation with the Department of Education. The disregard for method on the part of the former and the failure to realize the importance of a thorough knowledge of subject matter by the latter, can

are obstacles that can be easily overcome I am sure. The student would enter upon this course with the intention of becoming a teacher, just as does any student enter upon his professional course with the intention of becoming the professional man for which his training is preparing him. Few freshmen now come to the University of California with the intention of becoming teachers in the secondary schools, that I admit, but the reasons and the remedy for that are not for discussion here. Suffice it to say that when reward is adequate, then the profession will grow and become to be made up of the highest type of men and women.

The time of the Teachers Course is not far distant and it might be worth while to see what could be done without radical modifications in the curricula of the departments as they now are. For a working basis I would like to present the following skeleton programme, which seems practicable. In this schedule all preparation except that in subject matter and method is understood to be included in "electives". A major in Zoology is assumed. Each biological science department would have a course of similar plan built about its major as a core.

First year,
Geography or Geology
Aims of science and its human values.
Chemistry
Electives

Second year,
Zoology,
Physics,
Electives

Third year,
Zoology - advanced courses
Botany,
Physiology
Electives

Fourth year,
Zoology - advanced courses
Bacteriology, and Public Health

Electives

Fifth year,
Zoology - research
History of Science
Teachers' Course, correlated with, and supplementary to practice teaching.
Electives

The reasons for selection and sequence of subjects in this schedule are fairly evident from what has gone before, but a few points will bear additional explanation.

A course in the aims and values of science should be introductory, for in the absence of general knowledge concerning values, such as has grown up with other professions, the student must be given early in his work an enthusiasm for it and a sort of guide for future choice of subjects for study. The difference in aim between university and secondary school science must be clearly understood at the start. Too often, university courses accept science as an end in itself and it is taught from that point of view, whereas the prospective teacher must hold to his point of view, that to humanity generally science is only a very effective means to an end; it is just a faithful servant.

The schedule just submitted may seem to be overbalanced with science courses, but it must be somewhat so, especially if courses are not to be completely reorganized. Science would not need to consume quite so large a part of the time if special courses were given for teachers - another argument for a high grade, strictly professional course.

Duplication of teachers' courses in special methods would be eliminated for a single course for all of the departments of biological science would be sufficient. Biology is the hub, and not the separate biological sciences, in the courses in this field in the secondary schools. The methods concerned are <u>biological methods</u>,

and therefore a single course for all prospective teachers of biological science regardless of the nature of their major work, is a logical procedure. Whether such a course is a succes or a failure is largely dependent on the professor in gharge. in the past there have been many fialures, mainly because the person conducting it has never had secondary school experience, knows little or nothing of the problems, and has no sincere enthusiasm for the teaching of science to boys and girls below the university age.

The course suggested would cover an entire year. At least that much time is required to give any direction or instruction that is worth while. The first half of the year might well be devoted to a digestion and correlation of all previous work, organizing it into a form easily useable in the work to follow. Questions of method, recitation, laboratory and field work, textbooks and reference books purchase and use of equipment, must be given consideration in some part of the course. An outline course, with the separate lessons that make it up should be worked out in detail,for some particular locality, preferably the one where practice teaching is to be done. This should then be carefully tested by the criteria of a good biology course, as pointed out by the best authorities, and by common sense. But why make this skeleton outline beforehand? Why be prepared in anything? It will be too late to prepare at the moment the problem has to be met. Few new teachers will find a well planned course awaiting their arrival in a new field, and without previous experience a new teacher is likely to build up a course without due respect to relative values which comes only with a perspective of a course in its entirety. To illustrate, in the course given by an inexperienced teacher there is too much chance of

six weeks time being spent on the study of the grasshopper, with only four weeks left at the end of the school year to be devoted to the biology of the human. The mapping of a course, by way of practice, gives the prospective teacher practice in the exercise of judgment, with helpful constructive criticism.

Practice teaching now becomes only the trying out of the course and accompanying methods. As, one practice teacher remarked when this plan was suggested "But, I might have to make my course all over!" Such would often be the case. Any wide-awake teacher will change his course more or less from year to year. Even if the first plan were entirely discarded the energy and thought prompted by its making would not be lost. And now let us change the name given to those in charge of practice teachers. Advisor would be more fitting than supervisor, for they should remain in the background except for rendering helpful service, and making constructive criticism in excess of destructive.

In order for practice teaching to be effective there must be nothing of an artificial sort enter in. Conditions must be of the regular sort met every day in the teaching game. This statement seems superfluous, but a visit to some of the classes where practice teaching is being done will justify its insertion here. The practice teacher should not be handed over a laboratory properly equipped. Of course, the equipment should be available. The course should not be "ready-cut", The practice teacher must meet all of the problems and this is cheating him out of a part of his fun. Through his solution of these problems there will be a two-fold benefit, for the advisor too may profit, by the ingenuity of the newcomer. Resignation should be requested of any advisor who has outgrown the ability to learn. It is most likely to be the "green

person, who will develop really new methods, or evolve a more fitting experiment, or turn a bit of apparatus to a new use. Above all, the practice teacher should be required to scout for living material - there will usually be an abundance all about him, and much that is of interest should find its way into the laboratory. Training in the use of living material can not be over emphasized.

The course which I have outlined in the previous pages, is not satisfactory, but I firmly believe that it would be an improvement over the present situation. When tried out it would show many shortcomings, but by trial and improvement has our entire educational system evolved. Even an ideal professional course in use today would be obsolete toworrow. It would be unfortunate were it not so, for growth involves ecdysis, and growth is the law of nature.

Literature from which helpful suggestions were received during the course of this work.

Bagley, W. C. The training of teachers as a phase of democracy's educational programme. Ed. Adm. & Supervsn. vol.4 no.1, Jan.'18.

Balliet, T. M. and Robinson, C. H. Training of Science Teachers. N. E. A. Report, vol.54, 1916, pp.734-7.

Bessey, C. E. Preparation of botanical teachers. Science,N.S., vol.33, pp.633-9, 1911.

Boas, F. S. Teachers and research. Contemp., vol.116, pp.426-431. 1919.

Boggs, L. P. Making Teachers. School & Soc., vol.7, pp.369-74.

Caldwell, W. O. Preparation of the teacher of biology. School Sci. & Math., vol.16, pp.385-92.

Coulter, J. G. The training of elementary science teachers. School Rev., vol.24, pp.26-30.

Curtis, C.B. Secondary school science. Ed. Adm. & Supervsn., vol.3, Nov.1917.

Dewey, J. D. Democracy and Education.

Kent R. A. University preparation of teachers for high schools. School Rev., vol.27, pp.172-85.

Lange, A. F. Preparation of high school teachers from the standpoint of the university. U. C. A. Report, 1907, pp.718-23.

Lloyd, F. E. and Bigelow, M. A. The teaching of biology. 1909. Longmans, Green & Co.

Luckey, G. W. A. Essentials in the training of a teacher. School and Society, vol.1, pp.263-9.

McElroy, R. M. Teaching teachers. Ind., vol.93, pp.525- .

Pillsbury, W. H. Buffalo plan of teacher training. Elem. Sch. Jr. vol.21, pp.595-606.

Swift, F. H. College courses in methods of teaching high school subjects. Sch. & Soc., vol.6, pp.691-9.

Taylor, W. S. Project methods in teacher-training courses. Sch. & Soc., vol.8, pp.487-90.

Wieman, H. L. Teahcing the scientific method vs. teaching the facts of science. Sch. & Soc., vol.3, pp.243-5.

Williams, J.T. Teacher training in colleges. Sch. & Soc., vol. 9, pp.105-9.

Winship, A. E. Prepare rather than train for teaching. N. E. A. Report, 1918, pp.222-6.

- - - - - - - - Research vs. teaching. Sch. & Soc., vol.11, pp. 684-5.

- - - - - - - - Research as a means of teacher training. Sch. & Soc., vol.3, pp.243-5.

- - - - - - - - Reorganization of science in secondary schools. U. S. Dep't. Interior, Bureau Ed., Bull.26, 1920.

- - - - - - - - Cardinal principles of secondary education. U. S. Dep't. Interior, Bureau Ed., Bull.35, 1918.

Twiss, G. R. - Principles of Science Teaching. Macmillan. 1917.