curriculum by widespread, if slow, current displacement by other subjects; and, a fringe of high schools in which biology is either still an undiscovered subject or a forgotten one. Again, it is the grief of this subject that it is still pursued by long shadows from the Middle Ages, shadows screening from a people what our science has learned of human origin and destiny —a science sabotaged because its central and binding principle displaces a hallowed myth on the origin of man. Finally, the sum of these difficulties and partial frustrations—reinforced strongly no doubt by present unparalleled overflow of mentally restricted pupils into high school classes—seems unfortunately to be leading many high school teachers to abandon the teaching of biology as *science* and to drift with softness and ease into either the lullaby of hobbies or the smug acceptability of the practical.

But action and repair, advance and betterment, are the most legitimate offspring of this effort to take stock and learn. The new information should provide some sound bases for improvement. Will those who have either obligation or opportunity do their share? Will plans and action start at once and in many places? Though the high school teacher and his product are the things immediately involved, it is clear that his principal and school administrators, his city and state, his guides in professional and science training, must all find and contribute something that is essential to successful teaching of this science.

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The Training of Biology Teachers

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The teaching profession, because of its very nature, its importance to the nation, and the large number of actual and prospective candidates for it, has a right to demand a high degree of training, scholarship, and fitness from its members. The training of a teacher, whether it be for high school or for college teaching, should be especially thorough in the major field of the candidate.

To those who have been in the teaching profession for any length of time comes the realization that an instructor must know a great deal about his subject in order to do justice to the teaching of that subject. The science teacher in particular soon becomes conscious of any deficiency in training: he may find that he needs a larger number of laboratory techniques, methods, experiments, and practical experience in teaching.

Biologists have in addition a number of special problems related to the nature of their subject-matter. Some of these are suggested in the list below. The biology teacher should have some training in each of the topics mentioned; institutions engaged in the training of teachers can do a great service by attempting to train the candidates in as many of these divisions as fall within their scope:

1. Use of the microscope and its accessories.
2. Operation of various instruments and machines.
3. Preparation of necessary solutions.
4. Preparation of microscope slides.
5. Preparation of visual aids.

6. Handling and care of living things in the laboratory.
7. Field work.
8. Fundamental facts, principles and theories.
9. Research.
10. Teaching techniques.

I should like to discuss briefly the content of each of these divisions.

Use of the Microscope and its Accessories

It is surprising how many biologists and graduate students do not know the potentialities of their microscope and its various attachments: the camera lucida, micrometers, illuminating devices, prisms, filters, different objectives, etc. If information on these cannot be obtained from the various courses which a student takes, then a special course should be organized where careful training in the use and care of the microscope and its numerous attachments and accessories is given.

Operation of Instruments and Machines

In teaching, it sometimes is necessary to know about the operation or use of various machines and instruments, as film and slide projectors, microtomes, kymographs, autoclaves, centrifuges, manometers, balances, and micromanipulation apparatus. Of course, it is readily understood that the average biologist is not familiar with several of these mechanisms. However, that situation is easily remedied by the taking of suitable courses (microtechnique, physiology, bacteriology, bio-chemistry, cytology, etc.) during the summers or at other times. In such courses he will very likely make use of these instruments.

Preparation of Solutions

The preparation of various solutions which are used in biological courses sometimes falls to the lot of a teacher. These solutions may be preservatives, stains, culture media, standard solutions, indicators, and so on. To a certain extent the technique can be learned simply by following directions which are given in various laboratory manuals; but a course in chemistry, microtechnique or bacteriology fortifies one considerably against any difficulties that may arise in following these directions.

Preparation of Microscope Slides

Knowledge of how to make histological, cytological, or bacteriological slides for microscopic study is more or less of a necessity for a biologist, if for no other reason than to lead him to an appreciation and a thorough understanding of the various preparations his classes use.

Preparation of Visual Aids

A fascinating phase of teaching is the preparation of such visual aids as are of interest or value in one's field: charts, lantern slides, photographs, diagrams, drawings, posters, mechanical gadgets, or simple mechanisms.

A biologist who has a camera and who knows how to get the most out of it is a fortunate individual, for he can build up a great amount of interesting and original visual material for his classes. A little training, either formal or as a side-line or hobby, in elementary photography, developing, lantern slide preparation, and drawing techniques (ink, water color, oils, etc.) is a good thing for the candidate who intends to teach biological subjects. I have seen lantern slides and photographs prepared or taken by biologists which were not only excellent from the technical view-point but were splendid source material for ecological,

geological and naturalist lectures. The use of this material need not be restricted to the classroom, but may be extended to clubs and small informal groups. Incidentally, for those who are camera enthusiasts, the biological stations offer a golden opportunity to photograph wildlife in its natural setting, and also to get many forms which might be inaccessible if one were to depend upon his own resources and initiative rather than upon those of the station.

Because so much of biology is dissection, observation of structures and processes, demonstration and experimentation, the need for a knowledge of a few drawing principles and techniques (types of pens, papers, tracing and drawing devices, etc.) is definitely felt by many biologists, whether they be teachers or research men.

Care of Living Things in the Laboratory

Each instructor at some time or other is faced with problems centering around the handling, care, or raising of living things in the laboratory, whether they be bacteria, plants, or animals. In order to acquire techniques for the care and growth of bacteria one should take a suitable course in bacteriology. The problems of maintaining different kinds of plants—whether they be microscopic and grown in aquaria or in various culture media, or larger and grown in pots and beds—are not always suitably covered in ordinary botany courses, but may be learned through practical experience, observation, research, or while serving as an assistant in the botany department of a large institution. Also, local nurseries can be of great help here.

The larger animals commonly kept for laboratory use are the fishes, amphibians, reptiles, mice, rats, guinea pigs, rabbits, and cats. The smaller animals which one may have occasion to grow or keep in the laboratory are Protozoa, snails, arthropods (crustacea and insects), flatworms, and miscellaneous invertebrates. Sometimes, studies in high school or beginning college courses will bring in an animal (snake, opossum, squirrel, etc.) and the instructor will be faced with the problem of what to do with it or how to care for that particular specimen. Hence the need for some training along the lines of health, growth and food requirements, care of young and mature animals, and the eradication of pests and parasites. This training comes less from general biology courses than from practical experience, observation, or participation in research projects, or from assisting in a department where experimental laboratory animals are maintained.

Field Work

One of the most vital and interesting parts of a biological course is the field work. No matter how many laboratory courses a biologist has had, his biological training is still incomplete if he has never had a field course at some biological station. Some schools and universities have realized this and have required or strongly urged their students (graduate and undergraduate alike) to attend such a station.

A biologist should know where he can get or collect living things for his classroom, and after he has collected them he should know or find out how to care for them. This involves a knowledge of taxonomy, biota, physiology, ecology, natural history, and to some extent the geology of a region. He should be informed on some common species of plants or animals which are to be found in the immediate vicinity or region where he is being trained or where he is teaching. For example, he should

know those forms which may be found along the seashore, in salt water, in fresh water (ponds, streams, rivers), in or on land (meadows, caves, mountains, deserts, forests) and in other habitats. This type of information is most valuable to the biologist and makes a deep impression on those who come in contact with him. It is sometimes said of a biologist that he knows too much about things in books and in the laboratory and not enough about those in the great outdoors (natural history, ecology and practical geology). The quickest way to acquire this information effectively and pleasantly is by summer attendance at a biological station. (For a description of the stations in this country, with a list of the types of work offered in each, see THE AMERICAN BIOLOGY TEACHER for March and April, 1940.)

Attending one of these stations is a sure and enjoyable way to learn about wildlife, ecology, or geology of a region. Biology does not begin to take on real color or meaning until one has spent some time at such a station and has done some collecting and observation of species in their normal habitats.

The type of material one learns at such stations is very practical, for example one may find out: how a field trip is conducted; what supplies are necessary on a field trip; the care needed in keeping these supplies in good condition; the names and distinguishing features of a number of species of plants and animals; exactly where they may be found; under what ecological conditions they exist, survive, or thrive; the normal activities of these species; what happens when these normal activities are disturbed; how to collect and handle various specimens; what to do with them after collection and how to care for them in the laboratory; how to preserve them; how to experiment with them; numerous techniques or pointers on the study of development, dissection, anatomy, physiology and behavior of hitherto unfamiliar forms; what types of research are being carried on at that station by veteran and beginning investigators and what research problems remain still to be worked out.

There is much else to be said for the value of attending a biological station. For one thing, it is an excellent way to combine a vacation with a study schedule, since very frequently a large part of the work is out-of-doors and under very informal conditions. One is away from a great number of disturbing city-life influences and distractions and can work or study in peace and quiet under ideal conditions, in pleasant surroundings and with scientists who have the same interests but who come from all sections of the country. In addition, one may frequently get a number of excellent ideas for research from such a group.

To get the most benefit from a biological station one should have a good background in science courses before coming to such an institution. Inlanders and those who have never been near the ocean have a great deal to learn about aquatic organisms. For them a marine station has much to offer. Even those who have lived near the seashore for a good many years are amazed at the amount of either misinformation or ignorance which they had harbored until they took a course or two at a marine station. A biologist should try, if at all possible, to attend more than one biological station in the course of his training (this means after he has begun to teach, during the summers).

FUNDAMENTAL FACTS, PRINCIPLES, THEORIES

It almost goes without saying that a

science student or prospective teacher should know as much as possible about the data, facts, principles, theories, and history pertaining to his branch of science. This knowledge may be acquired in many ways. The most common method is by attending lecture and laboratory courses in various branches of the subject. It is unfortunate that some biologists, once they have obtained their Master's or Doctor's degrees, feel that they have nothing to gain by taking additional courses in summer school or during their sabbatical years. (We assume, naturally, that the courses are sufficiently well organized, have a worthwhile content and are properly taught.) Taking courses is one way that a teacher can keep from losing the student outlook, which is vital to successful teaching, and can gain a large amount of information in a short time, with comparatively little searching or waste of time on his own part. Courses furnish a skeletal framework or outline which can be filled out or augmented later, should the need arise. Incidentally, if at all possible, a biologist should take some of his training in several different institutions so that he has a broader outlook, sees different laboratory set-ups or techniques, and gets a large variety of courses.

Another method of acquiring some of the fundamental facts and principles is by independent study or research, although this way is harder and requires much more time. Constant reading of technical or abstracting journals, books on general or special phases of his particular branch of science, or other sources, is indispensable. Sometimes a well chosen reading list, faithfully followed, will do wonders in providing the biologist with the necessary background.

Still another way is for a prospective teacher or graduate student to obtain a position as laboratory (or research) assistant in a large university, particularly in an institution where a great deal of live material is used and where the assistant has considerable responsibility in setting up laboratory experiments or making preparations for class. Assisting is a most valuable experience, especially if it is carefully supervised and directed by a responsible older member of the faculty who takes the assistants in hand, coaches them weekly or oftener in the work that they are to do, the experiments which they should set up, the techniques involved in managing a laboratory or a class, the grading of papers, and a number of other important details which contribute to the smooth running of classes.

In large metropolitan areas there are a number of organizations, museums, societies, clubs, science academies, and groups of people who are interested in some phase of science—microscopical, ornithological, botanical, general science, chemical, bacteriological, ecological, entomological, parasitological, horticultural—which a teacher may join. Some of these organizations sponsor field trips, exhibits, study groups, lectures, forums, demonstrations and other projects, in addition to their regular meetings. One can learn a great deal from attending these meetings and functions. In addition to these local functions there are national conventions which are very worthwhile and stimulating.

Research

Whenever possible an instructor should be doing research along some line, in addition to his teaching. This applies particularly to college instructors, but should be an ideal of high school teachers as well. A number of excuses are usually offered why many teachers

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RIPLEY, S. DILLON. *Wild Ducks for the Asking.* Natural History 46: 171–176, 186. October, 1940.

The hobby of keeping wild ducks is spreading, and can be started wherever a natural or artificial pond may be planted with shrubs and trees and protected from predators by a low fence. A nucleus of wing-clipped wild birds will soon attract others that will readily breed within the sanctuary. Wood ducks have been brought back almost from extinction largely by the efforts of one Connecticut man. New arrivals to a pond occasion considerable interest. Males are accepted readily; females are more aggressive and seem to be the ones which establish "peck order" in the flock. This order, whereby an individual may peck at certain birds at will but is in turn chased off by others, seems to be established upon the basis of bluff rather than of size.

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do not carry on some type of research or individual creative work. Some of these excuses are valid and perfectly understood, as when the nature of the problem is such that facilities, equipment, or material is not obtainable in the institution or region where one is teaching, or where there are other restrictions on the particular type of research.

The value of research to the average biologist is not so much that he will make outstanding discoveries or contributions to science, but that he will gain a great deal from the mental stimulation which comes as a result of creative or research activity. Research gives the worker an opportunity to utilize training and abilities along widely varied lines, and to acquire new skills. It gives him practice in some of the following: foreign language translation, experimentation, making and keeping collections, apparatus construction, keeping posted on the new and most recent literature of a special field, drawing techniques, analysis, organization and compilation of research data, and writing for publication. It makes one really appreciate science, and feel as if he belonged in the field, because only by participating fully and actively in a field does one gain enthusiasm and real appreciation of that field. Another very important thing that research does for one personally is that it places him directly in touch with a select group of widely scattered scientists who are either specialists or are vitally interested in that particular field. Not infrequently these workers exchange data, specimens, and observations; and suggest problems for further research. They may even collaborate.

Naturally, the teacher's first duty is to teach his subject well. His second duty is to make a definite, tangible contribution to his field, in the form of research or creative activity. He should not do one and disregard the other. The schools training science teachers could do a great service if they impressed this important fact on their students. However, in stressing research as a part of a teacher's duty to his field, schools and universities should guard against excessive pressure for published results because too often that stimulates the production of a large amount of written work which is of very mediocre grade and which can do considerable harm in that it clutters up scientific literature with data which never should have got into print. The emphasis should be on *quality* of research and reliability of one's data and experiments, rather than on a speedy turning out of research. The editorial policies of some journals which cause articles to remain "in storage" for about a year before they are published are not so bad after all, be-

cause this allows an author to withdraw an article before publication should experiments performed subsequent to the completion of the article negate his former data or cause him to change his mind.

Teaching Techniques

In addition to training in fundamental facts, principles, theories, laboratory techniques, and research, a prospective biology teacher needs training in biological teaching methods and techniques, methods of presentation of subject matter, construction of various types of tests, the evaluation and grading of student work, tricks dealing with the mechanics of class organization and order, seating, roll-taking, quiz conduction, handling of laboratory supplies (ordering, inventory, upkeep, storage), and the handling of students.

Above all, the future teacher should be taught critical scientific methods of thinking—how to think for himself. This can not be accomplished in one course, but must permeate every science course which he takes.

Another sometimes neglected item is that of making the prospective teacher understand that he must give his very best efforts and interest to the job. It really does not matter a great deal whether one is preparing to teach in a high school, junior college, or a regular college, because for any one of these the prospective candidate needs as much preparation or information and as many techniques as he possibly can get, plenty of common sense, a willingness to work earnestly and hard in his chosen field and a desire to get ahead.

Books

Bush, George L., Dickie, Allan, and Runkle, Ronald C. *A Biology of Familiar Things.* American Book Company. 695 pp. 1939. $1.92.

This is a pioneer text. It is not a text with a prescribed syllabus, with an encyclopedia approach, or with a highly integrated organization. It contains much less technical material than is found in many of the accepted modern textbooks. The stress is on consumer biology. Its true value can only be judged by careful use of the text by teachers and supervisors.

Mechanical Make-up: It is a 6×9 inch sturdy book with a brown and light tan cover arrangement. It features photographs, using a superbly executed "bled" engraving as an introduction to each unit. Its photography is exceedingly sharp and distinctive. There is a polychrome engraving as a frontispiece. Sufficient visual material, with effective introductory phrasing to legends, undoubtedly should stimulate closer examination of non-typographical matter. The typography is in a single column with well spaced composition. Especially effective is the composition of the overview to each unit. A unique development is the graphic illustration of laboratory techniques.

Psychological Soundness: In theory this book might be the essence of the psychological approach. It stems from central basic interests of the boy and the girl of our suburban communities. It appears to add to, supplement, and lead on from his or her everyday experiences. There is no evident seasonal arrangement. Paragraph headings are in the form of direct statements, viz., "It takes