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Preliminary Impressions and Facts From a Questionnaire on Sec- ondary School Biology¹

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In December 1939 and January-February of 1940 the Committee on the Teaching of Biology of the Union of American Biological Societies, through its representative, Dr. D. F. Miller, mailed approximately 15,000 questionnaires to teachers of biology in secondary schools throughout the United States. From such teachers 3,186 returns have provided much information which will soon be fully analyzed, assembled and published under committee auspices. The expense of the investigation has been borne by a grant from the Carnegie Foundation for the Advancement of Teaching. THE AMERICAN BIOLOGY TEACHER assisted in publicizing the need for this study, and the members of the

National Association of Biology Teachers provided more than their share to the large number of returns which alone could give value to this survey. It therefore seems proper that the first impressions concerning what has been thus learned of biology teaching and teachers should be submitted to the N.A.B.T. and to its official Journal. It is thought, however, that this thumb-nail sketch of the results—though supported by no tabular or graphical data—will prove of value and interest to biologists and educators generally and perhaps to others.

First of all it is notable that the teachers who replied gave data for schools which enroll more than 3,000,000 secondary school pupils, and that the total number of biology teachers now teaching in those schools is approximately 7,686. It is thus evident that although replies

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were received from only about one-seventh of the high school biology teachers of the country those teachers gave data for schools in which approximately one-third of all such teachers in the United States are employed. We must therefore regard the data obtained as sufficient to provide much trustworthy information relating to biology in the average or better than average high schools of this country. The method of mailing the questionnaire makes it unlikely that the smallest and poorest schools were reached to an extent commensurate with their numbers. Only 2.7% of the replies were from non-accredited high schools.

Amount of biology taught. High interest attaches to information concerning the total amount of various biological subjects available to high school pupils in various schools throughout the country. In the following statements that portion or percentage of the "general science" course which is biological science has been properly credited to biology. The "hours" given are 60-minute hours per week for one year.

For the public schools in a group of 11 "large cities" of the United States the replies received indicate that least biology is offered (it is of course not necessarily taught to all pupils) in Milwaukee (5.7 hrs. per wk.), Boston (6.6 hrs.) and St. Louis (7.2 hrs.). New York City schools were suffering a definite reduction in their biology offerings (7.9 hrs.) during the precise time required for completion of this survey; at the present time the probable offering (7.0? hrs.) of New York City is less than that of the average high school of the United States (7.3 hrs.) and about 30 per cent less than the average amount offered (10.1 hrs.) by all cities (excluding the 14 specifically named in this and the next following paragraph) of more

than 100,000 throughout the U. S. Largest offering of biological subjects in this group of large cities is indicated in Kansas City, Mo. (18.8 hrs.), Washington, D. C. (16.5 hours.), "California" (15.3 hrs.), and Seattle (14.8 hrs.). Too few returns were obtained from Providence, Baltimore and New Orleans to warrant their classification in this report.

The geographical region which seems to offer least biology in its public schools is New England (6.7 hrs.). Next follow, in order of increase, the Southern (6.9 hrs.), Middle Atlantic (7.1 hrs.), Central (7.2 hrs.) and Western (9.1) states. The individual states with indicated lowest offerings in biology are Vermont (4.2 hrs.), Rhode Island (5.1 hrs.), upstate New York (5.6) and Maine (5.7 hrs.); those offering most, Utah (12.1 hrs.), California (10.3 hrs.), Missouri (10.2 hrs.) and Idaho (10.0 hrs.). It is especially notable that Milwaukee, Boston and St. Louis all offer less of biological science to their pupils than do the remaining schools of the states in which they are located. These values are: Milwaukee, 5.7, other Wisconsin, 5.9; Boston, 6.6, other Mass., 7.4; St. Louis, 7.2, all other Missouri, 10.6. How much the offering of these three cities differs from that of other large cities is indicated by the following comparisons: The average offering in seven large cities (New York, Philadelphia, Chicago, Washington, Detroit, Minneapolis, Seattle) is 11.1 hrs. Again, if all of the 11 cities which have been mentioned above (and also Baltimore, New Orleans and Providence) be excluded from consideration all other public high schools offer an average of 7.2 hours of biology weekly for 1 year; and, excluding the 14 cities hitherto named, all other cities of the U. S. with populations in excess of 100,000 offer an average of 10.1 hrs. of

biological science.

Thus one would especially wish to know just what conditions or forces are responsible for the marked restriction upon the offering of biological science in the public high schools of Milwaukee, Boston, St. Louis and present-day New York. Also, in upstate New York—whose near-minimum offering is outdone only by Vermont and Rhode Island.

On the basis of school samples obtained in this questionnaire, private schools (149) apparently devote slightly more hours (7.6) to biological science, and parochial schools (80) definitely fewer hours (6.0) to biology than do (2,166) public schools (7.3 hours).

In a consideration of the amount of biology taught in our schools two additional items are of outstanding interest. First, 11.6% of 2,472 teachers reported that in their schools a "social study has displaced a biological study during the past 5 or 10 years." Second, 19.8% of 2,581 teachers similarly report that in their schools a biological subject or unit was transferred to the teacher of physical education during the past 5 or 10 years.

The trends and tendencies thus clearly indicated by the figures just supplied by our high school teachers would seem sufficient to rouse action in all those who may stress the importance of biology in the education of a modern people. One wonders whether high school biology teachers and the many members of biological departments of our colleges and universities will forget and ignore both this continued threat and this clear evidence of a defeat and failure!

Frequency of various biological subjects in curriculum. For 11 states selected from all sections of the country the relative frequency of various biological subjects in the secondary school

curriculum was learned. Though there is some variation among the several states in the frequency with which physiology and hygiene is offered, it is clear that "biology" is offered far more frequently than all other subjects put together and that general science—though far less frequent—comes second to biology. This order is found to hold for every one of the 11 states included in this particular summary. The 805 informants report: Biology, 742; general science, 275; hygiene, 69; botany, 42; zoology, 25; physiology, 47; and a total of 8 variously named additional courses.

This item of information, of course, was already available from other sources, and very many people know that though courses in zoology and botany were the usual offerings of twenty-five years ago those subjects have meanwhile been superseded by biology and general science. But here one is tempted to ask: How generally have college departments of zoology and botany recognized—and provided for—this considerable shift in the training needs of our only body of teachers who have opportunity to teach biology to our people? By way of answer it can be said that we all know that some college departments have at least partially adjusted their course offerings to the newer needs. But a host of high school teachers now utilize the opportunity offered by this questionnaire to say plainly and directly that their college courses in botany and zoology did not at all provide them with the subject matter which is essential for them as teachers of biology in high schools. This word comes from those who have begun their teaching within the last 3 years perhaps as forcefully as from those who left college 10 or more years ago; and it comes from teachers in every section of the country.

Details of this emphatic verdict of our

high school teachers must await the fuller publication of these results; but it is painfully clear that if the biological departments in most colleges and universities regard the teaching of biology to a nation as a part of their function—and one which they would care to perform well—they will need to find more effective means of teaching biology to prospective teachers in our high schools. For those already teaching only well-planned summer laboratory and field courses can supply the type of instruction usually requested. Will American biologists increase and improve present opportunities for such training?

Amount of laboratory work. For 12 states which represent all sections of the country details concerning the average amount of laboratory work done in the various biological subjects are available. Since the very great majority of such classes are for "biology" and the next greatest number are for "general science" the present remarks will be limited to laboratory and recitation time in those two subjects. In all of these 12 states less laboratory time is devoted to general science than to biology. In the biology course least laboratory time is recorded by Massachusetts (1.2 hrs.); New Jersey (1.4); and Virginia (1.6); most by Texas (2.6); Louisiana (2.1); Ohio (2.0) and California (2.0). Intermediate and nearly equal amounts are recorded for the other five states: Indiana (1.9); Alabama (1.9); Oregon (1.9); Kansas (1.7) and Idaho (1.7). The laboratory work in general science follows a somewhat similar pattern with least in Massachusetts (0.75 hr.); Alabama (1.1); Indiana (1.3); Kansas (1.3) and Idaho (1.3), and with most in Texas (2.6); Ohio (1.9); Virginia (1.7) and New Jersey (1.7). When all biological subjects are considered it is found that the greatest amount of laboratory time

is given by the high schools of Texas, Ohio and California and least in Massachusetts, Idaho and Alabama.

It is evident that in many schools biology is not taught as a laboratory science though it is so taught in most schools. This summary contains the suggestion that the displacement of biology by general science practically involves not merely the teaching of less biological subject matter but a partial shift away from a laboratory science subject.

Field trips. A total of 1,774 teachers (of 3,186) indicate that their classes take one or more field trips. 49.1% (1,425) of the public school teachers stated the actual number of field trips taken in their biology course, and the average number of trips for this portion (about half) of the public schools is 6.4 per year. This number differs markedly in different states. Smallest numbers belong to Nebraska, 3.8 (18 replies); Indiana, 3.8 (68 replies), and Montana, 3.85 (12 replies); largest averages are reported by Florida, 12.6 (11 replies); Tennessee, 9.2 (18 replies), and Iowa, 8.9 (30 replies). The average number of trips is fairly uniform, however, for the different geographical regions, although the percentage of teachers who specify the number of trips differs geographically. Thus, New England, 5.8 trips for 38% of replies; Middle Atlantic, 6.2 trips for 39%; Western, 6.2 trips for 45%; Central, 6.5 trips for 54%; Southern, 6.7 trips for 62%.

Obviously this important way of teaching biology requires some special training of the teacher, and many teachers earnestly ask that colleges and universities provide special courses and facilities for such training.

Teacher preparation for teaching biology. Some facts relating to the amount of college credit (average num-

ber of hours) in biological science received by teachers in various types of public schools, and in the different geographical regions of the United States, are of interest here. With one notable exception—that of teachers in cities of more than 100,000—the teachers of New England appear to have less college training in biology than do those in any other section of the country; and it was noted above that the schools of New England offer the smallest amount of biology to their pupils. The average amount of college training (in hours) received by teachers in all types of public schools of various regions is as follows: New England, 29.7; Southern, 32.4; Middle Atlantic, 35.7; Central, 38.7; Western, 43.5. It is notable that the order in which the geographical regions are named here is precisely the same order they assumed above when their place in the series was determined by the amount of biology which the high schools offer their pupils. It thus appears that the smaller the amount of biology in the school curriculum the less well prepared is the teacher to teach that minimum. Teachers in the “large cities” of New England have more college training (57.2 hrs.) in biology than do teachers in “large cities” of any other section, though teachers reporting from “small cities” (10,000 to 100,000) in the Western states have equal or more college credit (59.0). Among the rural schools of the country the teachers of New England have least (19.6 hrs.) college training and those of Western states have most (36.5 hrs.).

Only 53% of teachers replying (2,931) to this item say that their “special preparation” was for teaching biology. It is therefore interesting, and seemingly complimentary to the subject, to find that with free choice of subjects 70% of 2,764 teachers say they now

prefer to teach biology.

The following information was obtained concerning the highest college degree held by biology teachers. In public schools we find this to be, bachelor, 49%; master, 38%; doctorate, 1.2%. In parochial schools these values, respectively, are: 54%, 27% and 1.0%; in private schools, 36%, 42% and 4.9%. In fields of *biological* science these groups of teachers have college credit in the following average amounts: Public, 37.6 hours; parochial, 30.1 hours; private, 33.8 hours.

Those biology teachers who have done *graduate* study indicate that such study was 41.2% biology; 14.7% other sciences; 32.6% professional education; and 9.8% other subjects. Nearly 69% of all teachers indicate they have taken at least one course in biological science in the graduate school. Of the 2325 replies to the question relating to this topic 92% indicate that teacher training of the biology teacher should include more training in subject matter; 8% speak for less training in subject matter.

On the subject of their own training very many teachers comment on the need for laboratory and field courses (college) in which the prospective high school teacher may learn *how* to present biology to students. In impressive numbers also they stress the view that biology teachers need to be fairly familiar with several related sciences. They frequently criticize both the large quantity and poor quality of the courses they took in “professional education.”

Teacher memberships in professional societies. A total of 2772 (of the 2900) teachers in public high schools noted their membership in one or more professional organizations. An attempt has been made, often merely on the basis of the name of the society, to classify these memberships into “educational,” “sci-

entific" (other than N.A.B.T.) and to note the number of N.A.B.T. memberships. As thus done this large group of teachers averages 1.8 memberships in educational and 0.55 memberships in scientific societies other than N.A.B.T. The 596 N.A.B.T. memberships provide an additional average of 0.22 memberships for the teachers reporting on this item and it thus appears that already this organization has much increased high school teacher memberships in "scientific" societies. States showing lowest average memberships in professional societies were Arkansas, North Carolina, and Florida; highest were Maine, New York and New Jersey. Only in New York did memberships of teachers in scientific societies equal those in educational societies.

From other sources we know that little more than one-tenth of the nation's teachers of secondary school biology are as yet members of the N.A.B.T. And the data of this survey indicate that, apart from the N.A.B.T., only about one-half of our public school biology teachers belong to any scientific association.

Stray items among many items: Only 68.9% of teachers utilize rooms specially arranged for biology (some unprepared rooms even in Philadelphia, New York, Chicago, St. Louis, etc.).

For 39.4% of biology teachers extra-curricular school activities interfere "much," or "seriously" with teaching.

Among the 110 schools of upstate New York from which questionnaires were returned 3 report "no biology taught." This is one in 37!

From public schools of all cities of more than 100,000 50.6% of teachers report that the average size of their classes in biology and general science is in excess of 34 pupils per class. For cities of 10,000 to 100,000 this value is 26.5%.

In Philadelphia all of 13 teachers, or 100%, report such oversized classes; and 92.3% of these average more than 40 pupils per class. In New York City 96% (96 of 100 replies) of classes are oversized. In Minneapolis 83.3% and in Detroit 80% of classes are oversized. In schools (3) of large cities of Rhode Island 100% of the classes in biology and general science exceed 34 pupils.

For all schools represented by these replies sex education was listed (in the numbers indicated) as a definite goal of instruction in classes in general biology (1,197), hygiene (461), physiology (215), botany (44) or another department of instruction (311). No such instruction is offered in schools reported upon by 959 teachers.

The method adopted for rating the equipment of the rooms where biological science is taught classifies 1210 as good, 866 as fair and 994 as poor.

In the present sample of all schools of the U. S. the course in general science is about 23.8% biology. Of those teaching this subject 34% were specially trained in biology, 32% in chemistry, 23% in physics, 4% in geology and 7% in other subjects.

Men returned twice as many questionnaires for this summary as did women—2,115 to 1,045.

Textbooks are most often selected by the teacher making the reply (1,124); next in frequency, by a committee of biology teachers (540), another teacher (495), the state (404), a superintendent (375), a principal (319), a city (216), a curriculum committee (130), a county (93).

The average length of class periods in the schools reported is 50.6 minutes. In many large cities this period is only 40 to 45 minutes.

The genetic inequality of human individuals is taught in the classes of 2,370

of those who reported, and in some other biology or social study course in these same schools in 445 cases. It was not personally taught by 440 teachers, nor in 320 of the schools reported.

Though about one-third of all biology teachers (and pupils) are represented in the schools reported only 523 "biology" (and 331 nature study, 151 bird study) clubs are listed for these schools.

The biology teachers who supplied these data had an average teaching experience of 11.3 years.

Textbooks in use in all public schools are unsatisfactory to 27% of teachers. Of 242 teachers in 9 separately summarized large cities 46.6% say the text in use is unsatisfactory.

The "graduate" training of biology teachers in rural schools of Michigan was 10.0% biology and 39.6% professional education. Rather similar travesties on "teacher-training" are encountered extensively throughout the United States.

Teaching and not teaching organic evolution. The question on this item was so subdivided as to facilitate the recording of fairly accurate information with a single check mark. It is notable, however, that 111 teachers omitted such a mark on this question and that only 1,457 teachers—or somewhat less than 50% of those who did make one or another reply to the question—indicated that they teach evolution as "the principle underlying plant, animal and human origin."

A next following item asked those who avoided or lightly considered the subject of evolution in their teaching to record the main sources and reasons for opposition to it. Only 73 acknowledged restraint "by action of our state legislature." Of the seven different brackets used for recording groups or types of opposition the highest single number, 285, represented those who found the

subject "opposed by a majority in our community." For the several brackets the ultimate objection is clearly that of religion. The bracket for "opposed by my personal belief" was directly checked by 233; and 216—only partly included in this group of 233—used a line or two to write specifically of their personal aversion or opposition. Approximately one in ten teachers who replied to the questionnaire did not hesitate to record their "personal unbelief" in the principle of organic evolution. There is reason to think that many others with the same view did hesitate thus to record themselves.

Any further analysis and all except a single word of comment on this discouraging information is deferred until full and final publication of these results. Biology has a Fifth Column of no mean proportions.

Topics teachers would emphasize. Teachers were asked to list the 4 or 5 topics on which they would place most emphasis in a high school course in "general biology." From one-third of the total number of questionnaires returned—from 15 states representing all regions of the U. S.—these topics for emphasis have been classified, counted and tabulated. Approximately 3,000 entries or topics were thus set down by 866 of the 1,088 teachers of these 15 states. Excluding such items as "animals," "botany," "biology"—which were set down with surprising frequency—only about 21 topics were stated 13 or more times, though hundreds of different topics (including stars, planets, neatness, posture, hobbies, fertilizers, pollination, pets, etc.) were mentioned one or more times for a total of many hundreds. Topics most frequently listed were: health-disease-hygiene (397), physiology (263), heredity (192) and genetics (90), conserva-

tion (127) and structure (102). The least popular among these 21 major topics were photosynthesis (13), biological principles (13), scientific method (21), behavior (29), adaptation (37) and evolution (39). Somewhat more popular than the latter group of subjects were insects (53), nature study (87) and taxonomy (88).

Though the very large amount of highly informative material obtained on this item shows that many biology teachers throughout the country have a sound grasp of their obligation and opportunity to teach a science, the data as a whole also clearly show widespread tendencies to teach biology not as *science* but (a) as paths to pleasing hobbies or (b) as a series of practical technologies. These tendencies involve and raise several serious questions.

The criticism implied in the statement just made—on the teaching of biology as “a series of practical technologies”—should be clarified, though this is done solely in terms of personal opinion of the writer. It may be highly desirable—the writer thinks it is—to teach high school pupils very much of the very practical in hygiene, in conservation, in nutrition, in animal husbandry, in sanitation, or in economic biology, etc. But even if this be granted there are two cogent reasons why no one, or any group, of these applications of biology should become dominating interests during the first one or two years which a high school pupil devotes to biological science. First, when taught as a science the contribution of biology to the education and mental discipline of an educable pupil is incomparably greater than when taught as a smattering of its applications. Second, the biological technologies will hang more superficial than his skin on any pupil smeared with them prior to an introduction to the basic facts

which relate and anchor them. This principle is and has long been axiomatic on the college and university campus for training in technologies of every sort—medicine, engineering, forestry, and the rest. Everywhere the rule is, the basic sciences first; applications afterward. Unless or until educators and school administrators comprehend this principle our secondary school biology will be a happy hunting ground for whims and fads and so-called “useful knowledge.” We can get quite properly to an excellent lot of “practical applications” in a third or fourth year of biological instruction in the secondary school.

After-image and retrospect. Data submitted by 3,200 teachers of biology in our high schools give clear evidence of a considerable body of well-trained biology teachers, professionally minded, alert to the best that the biological sciences offer to their immature pupils. Perhaps, however, it is too much to expect a flattering result from the teaching of a very complicated science to a nation when only 53% of the teaching group made “special preparation” for teaching that science. Indeed, this fact is especially discouraging and serious, when only 69% of those thus trained, and not trained, may teach in rooms specially provided for the subject; when only 39% of rooms have good equipment; when 26.5% of classes are oversized; when 27% of textbooks are unsatisfactory; when class periods are often reduced to 40 to 45 minutes; when field trips are either entirely omitted or taken in small numbers; and when about 40% of these teachers have extracurricular school activities which interfere much or seriously with their teaching.

Equally notable and serious are the restricted offerings of the subject in certain large cities and in entire states; the counterbalance of occasional gains in the

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.