

METHODS IN BIOLOGY

important to human affairs. If these questions are to be raised—as certainly they should be among the boys and girls who will be the adults of the near future—it should be made clear that *neither* heredity nor environment is more important—that each serves in a different way. Heredity provides the equipment, but the environment decides how much of that equipment may be used. Heredity sets the upper limits beyond which environment can accomplish nothing; the environment may set a lower limit, above which the best of heredity is useless. The future of society depends on the quality of its heredity and on an environment capable of bringing out the maximum of these hereditary capacities.

5. **Eugenics.** Eugenics is, admittedly, one of those composites which are known as applied sciences. Whether it is soundly enough established to be included in any science course, and whether it should be discussed with high school or even college students, are questions that have caused some concern to biology teachers. Only recently have there been indications that eugenics is going to find a permanent place both in high school and college teaching. Events of the last decade have made the younger generation wonder how far genetic factors account for the dependence of a third of the population on the other two-thirds, even in times of prosperity. It is one of the most hopeful signs for the future that young people are becoming interested in problems of human breeding. The careful scientist sometimes replies that very little is in actuality known about human heredity; but this seems no good reason for withholding scientific support from the application of what is known. To some of us it appears better to have eugenics kept closely connected with its chief scientific basis, genetics, than that it should be handled by propagandists in some other field.

The objection is raised by some of the older high school teachers that any discussion of human heredity may make young students morose, and be a cause of needless worry to youth who are not yet facing the issue of marriage. But ideas of eugenics, like most sex instruction, come too late if they are reserved for married adults. There is a growing belief that eugenic ideas

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should be given boys and girls at least as early as their first interests in companions of the opposite sex. This means that the instruction must begin in the early high school years. Since very few of the high school students ever get into college classes in eugenics, the instruction in the high schools must go far enough to hold over until the youth contemplates actual marriage.

There is some organized opposition to certain aspects of the eugenics program, and its introduction into the high school, and even into the colleges, must depend strictly on scientific foundations. In working out his policies in eugenic instruction, each teacher must proceed slowly until experience has shown just how much can be effectively offered adolescent boys and girls. Anticipating what is hardly yet in the elementary texts, the following may be submitted as the first materials from which to choose:

The heredity of a fair list of morphologic, physiologic, and psychologic characters in man is now certainly established, and a fair understanding of their course in heredity is now to be had.

There is every reason for believing that the effects of heredity and environment are as significant for man as for the other organisms which have been studied.

More than 2 per cent of our population is hopelessly dependent because of mental defects that are known to be hereditary. There is no record to show that this group ever produces any individuals that are socially valuable.

The percentage of hereditary defectives is constantly increasing, because such defects are spread by apparently normal as well as by abnormal individuals. The normal individuals from hereditarily defective families may carry the defects in recessive genes.

We face an indefinite increase in the number of such defectives unless we can in some manner prevent reproduction in these individuals. Already the care of these defectives costs more than the education of all the college students in the country.

The complete isolation of all such defectives (which no state has yet been able to afford), or their sterilization, are the only

two methods available for controlling the spread of hereditary defects.

While it would be very difficult to decide which was the socially more important and which the socially least important half of any population, there would be little difficulty in selecting the 10 per cent which is the greatest drain on the advancement of our social institutions. The limitation of reproduction among this 10 per cent may be necessary before we can expect any decrease in the number of helpless dependents. How the control of the group may be accomplished is a matter of debate.

While the mass of the socially worth-while individuals, and even some leaders have come from the middle classes, the data abundantly prove that most leaders have come from the group which is the best equipped in hereditary capacity and environmental training.

Young people who are hereditarily sound and environmentally privileged may contribute to the quality of society by planning to have as many or more children than the average for the whole population. With less than three children to a family, the hereditary line which they represent will soon become extinct, and society deprived of the qualities carried in that line.

6. **Evolution.** It is difficult to understand how any adequate presentation of biologic principles can be made without reference to evolutionary concepts. The whole scheme of taxonomic classification, and one's interpretations in comparative morphology, physiology, and behavior, are influenced by the data on evolution. There is no part of modern biology which has not been affected by this idea; and even though there is not complete agreement as to the particular factors that have been involved in evolution, there are no biologists who are not agreed that evolution has occurred.

While the biology course will, then, of necessity include evolutionary ideas and material, the teacher of beginners, especially in the high school, should confine himself to thoroughly established data, and omit references to evolutionary items which are not required for an understanding of biologic essentials.

Specifically, the data considered may be such individual variation as every man can see in the human, in plants, and in the animals about him, and the records from domesticated and laboratory organisms. No one, unless he is ready to insist that black is white, is likely to object to such material. Such everyday facts are well known to the farmer who grows improved breeds of cattle and grains and fruits which were not in existence a half century ago. The man who gardens for recreation is aware of the endless list of new kinds of flowers, shrubs, and trees which scientific horticulture has to offer him. The housewife who deals in a modern fruit and vegetable market cannot help but know that the old varieties have given way to new—to varieties which are astounding departures from the things that were available in grandmother's day. These everyday instances of variation and improvement, taken in connection with the abundant laboratory experiments on heredity, are, after all, the soundest bases for generalizations in evolution. The data from comparative anatomy, physiology, embryology, and even fossils are more circumstantial, and need not be pressed with elementary classes.

The evolution of man is, by some, conceived to involve special problems which lie outside of science. High school students are hardly qualified to evaluate all the data; and under the circumstances one is probably not justified in presenting bare conclusions on one side of the argument. In the high schools it would be a fair avoidance of prejudice to refuse to discuss human evolution. With college students, the situation is, of course, quite different.

It is to be noted that there are no state laws which seriously interfere with the presentation of strictly scientific data, in this or in any other field. There is good evidence that the public, practically everywhere, is ready to allow the presentation of established fact, although it may resent the use of the science to put across ideas that involve (even in part) another field of thought. The biology teacher who cannot present evolution without offending a community is probably indiscreet in the handling of the material.

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SELECT REFERENCE LIST IN GENETICS

In High School Texts

- BAKER AND MILLS. 1933. *Dynamic biology*, pp. 624-684.
CURTIS, CALDWELL, AND SHERMAN. 1934. *Biology for today*, pp. 613-650.
FITZPATRICK AND HORTON. 1935. *Biology*, pp. 400-481, 602-611.
HUNTER. 1931. *Problems in biology*, pp. 620-643.
KINSEY. 1933. *New introduction to biology*, pp. 369-459.
MEIER AND MEIER. 1931. *Essentials of biology*, pp. 469-497.
MOON AND MANN. 1933. *Biology for beginners*, pp. 440-474, 667-689.
PIEPER, BEAUCHAMP, AND FRANK. 1932. *Everyday problems in biology*, pp. 505-552.
SMALLWOOD, REVELEY, AND BAILEY. 1933. *New biology*, pp. 362-395.

In College Texts

- BARROWS. 1936. *Elements of general biology*, pp. 283-353.
BUCHANAN. 1933. *Elements of biology*, pp. 304-420.
BURLINGAME, ET AL. 1928. *General biology*, pp. 339-420, 527-586.
PLUNKETT. 1934. *Elements of modern biology*, pp. 365-494.
RICE. 1935. *An introduction to biology*, pp. 449-565.
WHITE. 1933. *A textbook of general biology*, pp. 471-539.
WOODRUFF. 1936. *Foundations of biology*, pp. 204-214, 267-371.

Special References

- BABCOCK, E. B., AND CLAUSSEN, R. E. 1927. *Genetics in relation to agriculture*. McGraw-Hill Book Co., New York.
BERRY, E. W. 1923. *Tree ancestors*. Williams & Wilkins Co., Baltimore.
*CASTLE, W. E. 1930. *Genetics and eugenics*. Harvard Univ. Press, Cambridge, Mass.
*CONKLIN, E. G. 1936. *Heredity and environment in the development of men*, pp. xvi + 387. Princeton Univ. Press, Princeton, N. J.

TEACHING PROBLEMS IN GENETICS

- DARWIN, C. 1859. *The origin of species*. Various editions, e. g. D. Appleton & Co., New York.
DARWIN, C. 1875. *Animals and plants under domestication*. Various editions, e. g. D. Appleton & Co., New York.
DAVENPORT, C. B. 1911. *Heredity in relation to eugenics*. Henry Holt & Co., New York.
DEAN, B. 1895. *Fishes, living and fossil*. The Macmillan Co., New York.
DE VRIES, H. 1907. *Plant-breeding*. Open Court Publishing Co., Chicago.
DUGDALE, R. L. 1910. *The Jukes*. G. P. Putnam's Sons, New York.
DUNN, E. R. 1927. "Evolution while you watch." *American Mercury* 11 (41):84-90.
GODDARD, H. H. 1912. *The Kallikak family*. The Macmillan Co., New York.
HUXLEY, T. H. *Essays*. Obtainable in Everyman's Library. E. P. Dutton & Co., New York.
KINSEY, A. C. 1930. *The gall wasp genus cynips. A study in the origin of species*. Indiana Univ. Bookstore, Bloomington, Ind.
KINSEY, A. C. 1936. *The origin of higher categories in Cynips*. Indiana Univ. Sci. Ser. 4.
LULL, R. S. 1917. *Organic evolution*. The Macmillan Co., New York.
MORGAN, T. H. 1919. *The physical basis of heredity*. J. B. Lippincott Co., Chicago.
MORGAN, T. H. 1925. *Evolution and genetics*. Princeton Univ. Press, Princeton, N. J.
*MORGAN, T. H. 1928. *The theory of the gene*. Yale Univ. Press, New Haven, Conn.
MORGAN, T. H. 1932. *The scientific basis of evolution*. W. W. Norton & Co., New York.
OSBORN, H. F. 1910. *The age of mammals*. The Macmillan Co., New York.
SCHUCHERT, C. 1924. *A textbook of geology. Part II (historical geology and fossils)*. John Wiley & Sons, New York.
*SHULL, A. F. 1936. *Evolution*. McGraw-Hill Book Co., New York.
SINNOTT, E. W., AND DUNN, L. C. 1932. *Principles of genetics*. McGraw-Hill Book Co., New York.

METHODS IN BIOLOGY

- *SNYDER, L. H. 1935. The principles of heredity. D. C. Heath & Co., Chicago.
- THIRD INTERNATIONAL CONGRESS OF EUGENICS. 1934. A decade of progress in eugenics. Williams & Wilkins Co., Baltimore. *For teacher reference only.*
- WALTER, H. E. 1922. Genetics. The Macmillan Co., New York.
- *WINSHIP, A. E. 1900. Jukes-Edwards. A study in education and heredity. R. L. Myers & Co., Harrisburg, Penn.

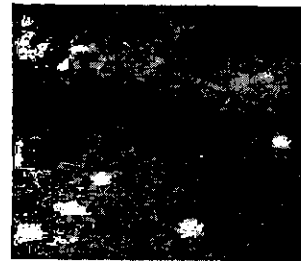
REFERENCES: TEACHING GENETICS

- BALLEW, A. M. 1929. Evolution, heredity and eugenics in high school biology. *School Sci. & Math.* 29:353-356.
- BRADLEY, J. C. 1931. The teaching of the principle of homologies to elementary classes in biology, and the use of phylogenetic series in the laboratory. *School Sci. & Math.* 31:525-532.
- CALDWELL, O. W., AND WELLER, F. 1932. High school biology content as judged by thirty college biologists. *School Sci. & Math.* 32:411-424.
- KILANDER, H. F. 1935. An experiment to illustrate Mendel's Law. *Sci. Educ.* 19:70-72.
- KIRKWOOD, J. E. 1918. Opportunity and obligation in botanical teaching. *School Sci. & Math.* 18:579-587.
- LOVEJOY, A. O. 1929. Anti-evolution laws and the principle of religious neutrality. *Bull. Amer. Assoc. Univ. Prof.* 15:307-314.
- MAYHALL, M. P., AND McSPADDEN, W. M. 1932. Life of the past—a unit for a course of study in high school biology. *School Sci. & Math.* 32:711-720.
- MORRISON, T. F. 1935. A demonstration model for genetics. *School Sci. & Math.* 35:571-575.
- RABER, O. L. 1914. "Evolution" in the high school. *School Sci. & Math.* 14:323-326.
- TURNER, T. W. 1927. The curriculum and aims in biological teaching. *School Sci. & Math.* 27:681-690.
- WESSEL, J. P., AND COLIN, E. C. 1933. Laboratory studies in genetics. *School Sci. & Math.* 33:165-170.
- WOOSTER, L. C. 1919. Do use and disuse modify heredity? *School Sci. & Math.* 19:45-49.

* Recommended as the best books for student use.

CHAPTER XXII

TEACHING PROBLEMS IN ECOLOGY



ECOLOGY IS THE SCIENCE WHICH IS concerned with the relationships of organisms and their external environment. Since it is a characteristic of protoplasm that it readily reacts to stimuli, the ecologist considers that the reacting organism in its environment is nearer reality than single plants and animals, or such

parts of organisms as are brought into laboratories for examination.

The older natural history consisted in large part of ecology, with which were combined portions of what are now called taxonomy and behavior. The formal development of modern ecology is a thing of the last two decades.

OBJECTIVES

1. **Interesting students.** For average future citizens who will meet the living world under natural rather than under laboratory conditions, ecology and behavior will probably contribute more of interest than any of the other biologic sciences.
2. **Practical applications.** There is no science which contains as much applied biology as ecology. Here are the biologic bases of the problems involved in any search for food and clothing among the plants and animals of the world; the utilization of favorable environmental factors in the production of crops;