

**THE RELATIVE EMPHASIS TO BE GIVEN PHYSIOLOGY,
MORPHOLOGY, ECOLOGY, AND OTHER PHASES
OF BOTANY AND ZOOLOGY.***

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That morphology, physiology, ecology, and systematic biology should each receive a place in a high school course in botany and zoology is a theory which at this date no longer needs defense. Their right to consideration is recognized by nearly all instructors, of both collegiate and secondary institutions. The recognition of the importance of economical biology is possibly not quite so general.

What is their relative importance, which is better suited to the minds of high school pupils, how much of a place in the course each deserves is not so uniformly agreed upon.

The question of the relative emphasis which each of these phases should be accorded may be considered from two viewpoints, namely, the relation which each bears to the life of plants and animals, and the disciplinary, cultural, and informational value of each.

Of the several phases to be considered the one which is most obviously connected with the life of the plant, is that of physiology. Life is evidenced by functions. The activities of an animal are almost the first thing the pupil sees. With plants the matter is different. It is rarely that the entering pupil has any conception of a plant as an organism which is as much alive as his own body, and the one way in which to lead him to realize that it is living is to aid him in discovering its activities. He might study minutely the anatomy of every part of a plant and he might know that before he cut it up it was alive because it was capable of growth, but it would still be a relatively lifeless thing till he inquired into its physiology. Let him once demonstrate its exhalation of carbon dioxide, its absorption of oxygen from the air and immediately it becomes a thing possessed of life, akin to himself. A knowledge of the physiology of plants or animals is essential to a right conception of their life.

On the other hand function is determined by structure, and

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structure is affected by function. A right conception of a function cannot be formed without attaining some knowledge of the structure which performs that function. Illumined by physiology, morphology becomes a division of the subject intimately related to the life of either plant or animal.

In ecology the student is brought face to face with the problems which the plant or animal has to meet as it makes and keeps for itself a place in the crowded world. As sociology concerns itself with the general life of humanity, the life of the individual as related to that of the mass, so ecology is constantly concerned with the organism's responses to the conditions which surround it and help or hinder its life.

Systematic biology may not at first thought seem to bear closely upon life. If, however, it be so taught as to develop in the minds of the pupils an understanding of the great relationships of the groups of plants and animals and a recognition of the fact that the development of these great groups has been a response to environmental conditions, they will thereby obtain a comprehensive view of life, a vision of its meaning which can come to them in no other way.

In disciplinary value each has its own advantage. Morphology excels as a means of training in accuracy of observation, in truthful seeing, and, as a means of developing constructive imagination, powers which count for character and for culture. Physiology also demands accuracy of observation, and affords a training in honesty, absolutely strict truthfulness, unsurpassed by that of any other subject in the curriculum. Not the least of its values is its power to develop intellectual independence, to give the pupil the consciousness that he can think for himself, and to train in him that most effective method of thought, the scientific method of inquiry.

Systematic biology has a value all its own in teaching the pupil to classify facts, to recognize the points which seemingly unlike things may have in common and so classify them; it develops in him the ability to classify thought and to generalize, an ability which is most necessary for clear thinking, which makes the difference between a man of information and a man of intellectual power.

In ecology, however, we come to somewhat dangerous ground. Unless the pupil be held constantly in check, the gain in in-

tellectual honesty made in physiology may be all undone by the conclusions too hastily drawn from insufficient evidence. In a subject where so little is absolutely known, where so much is as yet but theory, young pupils are too easily satisfied to state mere speculation as fact, and there is a constant necessity for guarding against careless theorizing which easily leads to a really careless disregard for well-defined truth.

From the point of view of informational value of a sort which lends to culture, somewhat less perhaps can be said for anatomy and morphology than for physiology and ecology, though each has its right to recognition here. The natural history of plants and animals is readily recognized by the world at large, whether by biologists themselves or not, as affording the most interesting kind of information, as tending more to produce a sympathetic attitude towards the plant and animal life than does mere anatomical knowledge. Ecology and physiology related as they are to life are better adapted to arouse in the mind the sympathetic attitude, than are strictly structural studies.

If information is to be regarded, as it unquestionably is, as a legitimate end of education, then economics have a rightful place in the course. Biology has discovered facts the practical application of which has affected the life of humanity as deeply as has any discovery of physics or of chemistry. No teacher of physics could contemplate the teaching of the subject of electricity without developing its economic importance. Why should a teacher of zoology guide his students through a study of the insects and fail to discuss with them their importance as enemies of man or contributors to his happiness? Why should he consider the birds and fail to show their value as insect-enemies when without them vegetable life would be an impossibility? Every pupil has a right to know these facts, not merely to know them but to feel them as a result of his own observations. There can be no surer way of broadening his sympathies, of leading him to that appreciation of life which marks the cultured man. Can any citizen of our country to-day be regarded as a man of culture who is entirely ignorant of the services our government is constantly rendering the nation through the biologists who are spending their lives in its service? The knowledge of the plants and animals and their places in life which systematic biology gives is recognized by all as information which is cultural in its character.

To summarize: Physiology has great disciplinary and informational value and is most intimately connected with life. Ecology such as can be accomplished by high school students is inferior in the first respect but deserves much attention for its informational value and its direct connection with the life of the organism.

Morphology, possessing great disciplinary value and forming the foundation for physiological and ecological studies, is almost as important as those studies themselves.

Systematic botany, for all three reasons deserves its share of attention. Economics, important solely as an informational division of the work, may claim the smallest place.

To attempt to say how much of the course should be devoted to each division of the science would be an absurdity. Physiology requires less time for its demonstration than does anatomy, therefore, though we may conclude that it deserves greater emphasis we must give it less time. To develop anatomy and morphology and, separately, from them, to teach physiology, either at the beginning of the course, would however be a means of over-emphasizing the former subjects. If physiology, as it naturally should, is made to accompany the structural work, then it can receive the emphasis it deserves. For instance, in botany, as roots are studied, osmosis, root pressure, and acidity of roots should be demonstrated. As the structure of the leaf is developed, the processes of photosynthesis and of transpiration must be developed. No piece of anatomical work may be allowed to lack its correlated work in physiology. So only can the structure be related to the life of the plant. Similarly ecology and morphology should go hand in hand. The crab apple's thorny branches, the thistle's spiny veins, the rose's prickly epidermis attain meaning only when the possible uses of these modifications are considered. Similarly these phases should be constantly related in zoological studies.

Let it be emphatically stated, however, that no anatomical or morphological work should be performed which does not bear directly upon the understanding of the functions, either physiological or ecological of the structure in hand or upon its rank in the plant or animal world.

Systematic biology is essential. In botany there is a tendency to give more time to the morphological studies of the types chosen to illustrate the great groups than seems necessary in order to

develop the relationships of the groups and a recognition of the principles of evolution. Some of the time frequently spent upon this work could more profitably be given to field-study and to observations of forms and the learning of facts which touch more closely the life of the pupil, and the knowledge gained from such work would be of a sort which would have a more broadening influence upon the pupil's sympathy with nature and would tend to give him wider interests in life. To learn to know mosses from liverworts and algae from either when he sees them in their natural setting will add more to the pupil's enjoyment of life than will a detailed study of the structure of a liverwort's antheridiophore or of the anatomy of a sea-weed.

In zoology the same principles are to be applied, and as much ecological study of many forms as can be performed without so weakening the work in anatomy as to impair the understanding of function or of rank, should be made a part of the course.

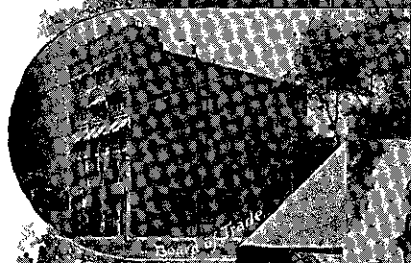
In both subjects, wherever it is practicable, the economic value of form should be noted, and practical application of knowledge gained should be made. Yet this work should be incidental, never receiving disproportionate emphasis. It has been through the practical application of man's long acquaintance with the things of Nature that he has gained supremacy; to omit economics—applied biology—from the course would be to ignore the influence of contact with the plants and animals in the development of our race. Both zoology and botany have accomplished marvelous changes in the life of man—many of the discoveries in both sciences within the last century have had an enormous effect upon the happiness of the race. To ignore this side of the subject would be to scorn a means, not at all to be despised, of arousing a most helpful interest in the subjects and an appreciation of them on the part of the public which unhappily is not infrequently lacking. There are still reforms to be accomplished. The destruction of forests and the wanton killing of birds may be sooner lessened if our pupils learn their value. But because of its lack of disciplinary value, and the tendency which would soon arise to regard man as the centre of the world for whose benefit all other creatures have their being, the economical side of biology is to be given less attention than is any other phase of the subject.



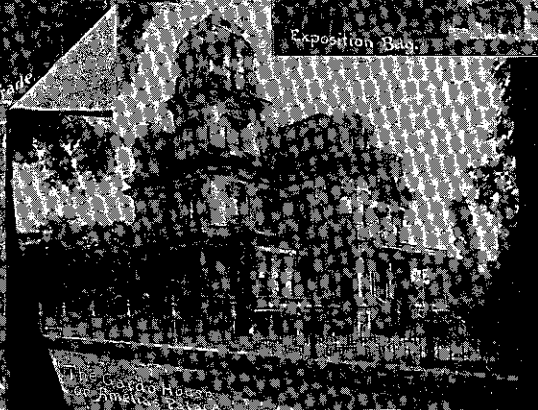
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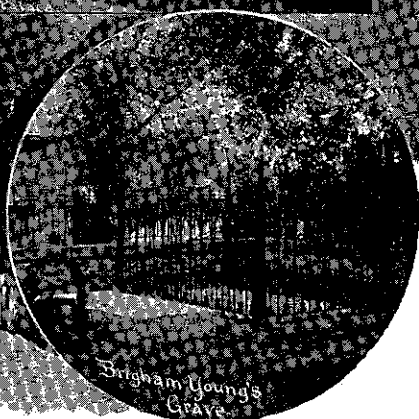
Exposition Bldg.



City Hall



Amato House



Brigham Youngs Grave



Under the
Red. pl. wall.



BRIGHT ANGEL CAMP AND START DOWN THE TRAIL INTO THE GRAND CANYON—SANTA FE ROUTE