sionally called "Dark" Absidia will serve as a convenient example. The collection of this species consists of 40 races. They have been contrasted with one another by twos in watch-glass cultures and all the possible combinations have been made as shown in the table. Grades A to D were assigned to the different strengths of sexual reaction measured by the number of zygospores produced in a given contrast. Each race was given a final numerical grade made up of the average of its reactions with all the other races and the races were arranged in the table according to their final grading. The plus and minus races were placed in series by themselves. There was no reaction when a plus was contrasted with another plus nor when a minus was contrasted with another minus. Whether they were of equal sexual vigor or one was weak and the other strong, the result of contrasting two races with the same sign was always negative. The collection of races therefore seemed dimorphic so far as sex is concerned. A race was either shown to be plus or minus or showed no reaction in a given combination and was provisionally classed as "neutral." There were no races evident that could be called sex intergrades.

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(*To be concluded*)

AN ANALYSIS OF AIM AND INCENTIVE IN A COURSE IN GENERAL ZOOLOGY

INCENTIVE AND AIM

That an incentive is necessary for the accomplishment of work is a postulate that needs no discussion. A review of my work as a teacher has led me to investigate the incentives that activate my students—mostly freshmen plunged into a course in general zoology. I have felt for some time that the aim of the course did not furnish an incentive for work.

Aim is confused with incentive because in some cases the two are equivalent. Aim is an aspiration for an ideal while incentive is an earthly motive. The statement of an aspiration may form an incentive for a few; but for most students the aim is soon forgotten.

INCENTIVE OF STUDENTS IN GENERAL ZOOLOGY

Since the motive that actually completes the work is not the aim, it is worth while to inquire what is the incentive. I recognize that the material with which I have to do shows a great deal of individual variation. In this "population" four classes can be discerned.

1. Those who work because the aim furnishes the incentive. In a so-called "general culture" course this is indeed a small class; in a technical school, however, the condition is reversed.

2. Those who work because of love for the subject, another small class. Although in some students this desire is inborn and probably hereditary, yet the proportion can be raised by an inspiring teacher.

3. Those who work for rewards. Our institutions, in their wisdom, through years of experience, have devised grades and honors. Some students have an inborn and probably hereditary ambition to seem better than their fellows and so react to this stimulus. Indeed competition can furnish a splendid incentive.

4. Those who work through fear. The same machinery erected to appeal to the ambitious reacts to prod the laggard. Under the threat of probation, condition, and exclusion, the victim struggles on. This is a large class and, in some ways, the most interesting. Although this group contains the dullards, yet the ranks are far from being homogeneous—the most brilliant member of the class may be buried in its ranks. How often have we seen a student, who, by constant threats, has just managed to scramble through our course, enter a technical school and not only lead his class but in time his profession. Lack of incentive is the key to his attitude toward the course in zoology. Being a more reasoning being than his fellows who work for love or rewards, and, feeling that the aim did not furnish an incentive, he gave his energies where, to his mind, results would be of more value.

THE AIM OF A COURSE IN GENERAL ZOOLOGY

It would be futile to list all the aims of a course in general zoology since two stand out in such bold relief that all others are cast into the shadow. These two are as follows:

1. To teach *science* which will give the student the method to gather zoological information and to use it.

2. To direct him to gather such information that will make him understand himself and his environment which in the end will make him review his moral and social responsibilities, leading to an intelligent selection of action in after life.

SCIENCE

These aims hinge on definitions and no definition will have more influence on the conduct of a course than the definition of science. Those teachers who define science as *knowledge* will have a different aim for their course than those who define science as *method*. While the students of the first class will get much information pumped into them they will get little training in method. Science, defined by Huxley as "common sense at its best," or organized common sense, can be analyzed as follows:

2. We observe (experiment).

3. We record our observations (experiments) clearly described in an *organized* form that others may repeat and confirm them.

4. We draw conclusions, at the same time discussing the results of others that have come within our experience.

Zoologists, botanists and even chemists feel that they have so much information to impart that they quite forget to teach science in the elementary course. It fell to the lot of the writer to get his first training in science out of a course of history. A problem was set, original sources of history were supplied, the data recorded, and conclusions drawn. Because his science teachers held that science was knowledge they made the imparting of information the most important aim.

OBSERVATION

To see one must be trained to see. He who is brought up on a diet of books alone is apt to be as "blind as a bat." As President Eliot and others have repeatedly pointed out, biology is preeminent among sciences in giving training in observation. Training in observation, therefore, is an important aim in a course in general zoology.

THE RECORD

To record observations two methods of description are available, descriptions in words and descriptions by drawings. The former includes logical arrangement of matter organization and the clear use of the English language. Where the objects or processes to be described are complicated, words alone are too cumbersome, so the graphic method supplies a short-hand method of accurate description. Drawing is not an end in itself. It is not used as in art to express the impression of an object, but to indicate relationships that can not be briefly or clearly expressed in words. Therefore, a course in general zoology has for aims training in the use of the English language, organization and drawing.

THE CONCLUSION

In the conclusion the organized data and its relation to some logical principle is discussed; and inferences are drawn involving cause and effect. The importance of the biological principle justifies the drudgery of the work. The drawing of conclusions from organized data is an aim in a course of general zoology.

INFORMATION

To understand himself and his environment is an aim too abstract for a student to grasp without the background that the course is designed to give. This aim is not apparent until the course has been completed. It is, therefore, necessary to consider a series of minor aims that come, to some extent, within the previous experience of the student, such as phases of morphology, physiology, behavior, evolution, heredity, etc. Since morphology is so much easier to treat in the laboratory, we are apt to center on it and so fail to impress the student with its relation to the real aim of the course.

An aim of a science course is to give training in how to do with a background of knowledge which will allow of a selection in the matter of action. An aim of a biological course is to give training in how to use eye, hands, and brain in the control of ourselves and our environment, with a background of knowledge that will allow of a selection of action.

AIM, INCENTIVE AND CONTENT

Aims, as outlined above, furnish little incentive for work. The ultimate object is too big a picture to be "interpreted" by one so close as a student in a laboratory class. The needed perspective can only be acquired after the course has been completed. Minor aims, clearly within the experience of the student, selected with a thought not only to the principal aims but also with the available material in mind, must be presented. These aims must seem to the student clearly important. Experience has shown that a combination of the problem method as illustrated in Hunter's "Problems in Civic Biology" and the project method now being worked out by teachers in the high schools gives the most science and information with the most incentive.

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PHYSICAL METHODS AND MEASUREMENTS, AND THE OBLIGATION OF PHYSICS TO THE OTHER SCIENCES

Several months ago there appeared in Science a brief article[1] by the present writer in which he advocates a carefully planned course in physical measurements, supplementing the beginning course in college physics, to suit the needs of students of the chemical, biological and the related sciences. In response to the article, there have been received more than twenty communications from scientific workers in the colleges and in the industries, relative to the subject. They are unanimous in expressing their agreement with the views stated. At the same time they express doubt as to the existence of a college physics department which will offer a course designed especially for the science student outside of physics.

To those who are working in the various experimental sciences, or who are in position to see and judge the work in numerous laboratories, it is evident that the need for better training in physical principles, methods and measurements is an urgent one.[2] To secure evidence of the truth of this contention, one needs only to obtain the views of the heads of industrial laboratories in which the services of many science graduates of our colleges are required. Or let the physicist who is—and, more than anyone else, should be—interested, interview his scientific colleagues to learn how much the lack of familiarity with physics may have proved a handicap in their own work or in that of their graduate students. There is concrete evidence in the report that some of the industries are contemplating or have already taken steps towards establishing training schools for their young technical graduates, to give them the sort of training which the colleges should have provided.

It seems to me that here is clearly an obligation upon the physicist. It is also an opportunity. It is an opportunity in the sense that if he could be instrumental in providing the coming generation of scientific workers with adequate training in physics, greater progress in science might assuredly be looked for. This not because physics is at all more potent than the other sciences in exploring the unknown, but because it is so fundamental. At every turn we encounter a physical phenomenon; every experiment that is planned involves some sort of measuring instrument, some form of control device, some physical method. Physics plays such an obviously important part in the great majority of researches that it leads one to wonder why

1 Science, N. S., 50, 199, 1919.

2 On this point "Chemical and Metallurgical Engineer" says: ". . . we know from experience that an adequate familiarity with them (physical methods) is far too often lacking among young chemists, and Mr. Klopsteg's proposal would seem to cover an important gap."