TABLE III

MEDIAN DIFFICULTY OF QUESTIONS UNDER SUBDIVISIONS

Type of material	Number of questions	Median difference	P.E.$_{md}$
Clothing	12	− 3.3	.5
Food	27	− 2.8	.9
Earth, weather, geology	79	.1	.4
Human biology, health	60	.6	.5
Life processes and development	20	1.9	.7
Properties of matter	8	2.5	.8
Plant and animal biology	49	2.8	.7
Biography	34	2.9	.6
Astronomy	19	3.2	.8
Light	51	4.0	.8
Chemistry, air, water, matter fuels	115	4.4	.4
Heat	48	6.0	.7
Simple machines, work, laws of mechanics	50	6.4	.9
Sound	19	9.9	1.8
Measurement, introductory method	19	11.2	1.6
Fluids, barometers, pumps	32	11.9	1.1
Electricity	68	12.0	.9
Applied mechanics, engines, etc.	38	22.2	1.3

cial silk made from wood pulp is called rayon; iodine mixed with starch gives a dark blue color; a disk one third red and two thirds yellow appears to be orange when rotated rapidly.

Boys are superior to girls in answering these: Lamp cords are insulated with cloth and rubber; a dry cell is contained in a zinc can; an airplane with two sets of wings is a biplane.

Apparently a large part of the differences can be explained by environmental factors differing in the experience of boys and girls. These factors may or may not explain the much greater interest of boys in mechanics. At any rate, sitting in the same classes, reading the same text-books, receiving instruction from the same teachers do not operate effectively in eliminating sex differences.

This study brings out more questions than it solves. Should we shift emphasis on the course for boys and for girls to attempt to equalize their achievement? Is one course over mechanics adequate for a girl who must live in houses and offices dominated by machines? Do sex differences carry over to teachers of general science? What advanced sciences should be provided for girls, since they are so obviously handicapped in physics? Should boys and girls be taught separately since their interest as manifested in achievement is considerably different? Should boys and girls be graded on the same distribution?

CONCLUSIONS

General science is far from standardized in textbook treatment, the range of completeness being from 48 per cent. to 82 per cent. of a random checklist of items.

Material in general science is not arranged in either uniform or logical manner.

Material generally covered in biology shows no sex difference in general, but the subdivisions show slight differences.

Physiography material shows no sex differences.

Chemistry material shows significant differences in favor of boys.

Physics material is much easier for boys than for girls, the median differences on subtopics ranging from 4 to 22 per cent.

The subject as a whole is much easier for boys than for girls.

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PROGRESS IN WESTERN DUCK SICKNESS STUDIES

A RECITAL of the events and experimental work that have led to a new concept of western duck sickness, formerly attributed to the toxic action of certain soluble salts of "alkali," was published in SCIENCE late in 1930.[1] The findings there chronicled strongly suggested that a type of botulism was involved. A supplementary contribution by Drs. Giltner and Couch,[2] appearing at the same time, set forth the fact that the bacillus of *Clostridium botulinum*, Type C, was present in mud obtained at Tule Lake, California, as well as in the tissues of wild mallards, pintails and ring-billed gulls that had died of or were killed while afflicted with duck sickness.

Despite the highly suggestive character of these circumstances and other facts revealed, including the striking similarity of the syndrome of duck sickness and that of botulism as manifested in "limberneck" of domestic ducks, there still remained the necessity of demonstrating actual toxin production under field conditions, and in media or associated with food or water likely to be ingested by birds. With an organism as prevalent and widely distributed as *Clostridium botulinum*, the need for such added evidence is obvious. As expressed by Geiger, Dickson and Meyer,[3] "the

[1] E. R. Kalmbach, "Western Duck Sickness Produced Experimentally." SCIENCE, lxxii, 1878, 658–659, Dec. 26, 1930.

[2] L. T. Giltner, J. F. Couch, "Western Duck Sickness and Botulism." *Ibid.*, 660.

[3] J. C. Geiger, E. C. Dickson and K. F. Meyer, "The Epidemiology of Botulism," U. S. Public Health Bulletin No. 127, pp. 1–119, September, 1922.

mere isolation of this organism from the suspected feed or intestinal tract or spleen of a dead animal is insufficient to support the diagnosis of botulism." There is always the likelihood that tissues may be invaded after death by this saprophytic anaerobe which, in the form of a few adventitious spores, may have been making harmless passage through the alimentary tract at the time of the creature's death, brought about by factors that may have been wholly foreign to botulism.

Demonstration of toxin in the field, therefore, in concentrations lethal to birds and in, or closely associated with, likely food items, constituted the primary objective of the past season's study of duck sickness conducted by the Biological Survey in southern Oregon and northern California. It was the logical sequel to the progress made in 1929 and 1930, and it constituted the final unforged link in the complete chain of evidence. Without such toxin demonstration the concept of botulism being the cause of duck sickness still would remain, at least to the bacteriological world, an unproved theory.

It is gratifying to be able to announce that this primary objective was attained, not once, but in at least twenty different instances during the summer of 1931. In each case toxin was demonstrated by the feeding or inoculation of experimental birds (mainly pigeons) with material obtained directly from field sources. Necessary toxin-antitoxin tests were made on every occasion, definitely identifying the toxin as that originating from *C. botulinum,* Type C, of Bengtson.

The media in which toxin was demonstrated included the bodies of birds dying of duck sickness, mud in the immediate vicinity of such bodies, water from shallow pools in infected areas, living and dead larvae of sarcophagid flies, submerged barley and other grains that had lain on mud flats where they were subjected to high temperatures and an alkaline environment. Under conditions that were strictly experimental but which might easily occur in the field, toxin also was demonstrated in a mixed mass of insect remains, copepods, snails, algae and Lemna. The organism, but not its toxin, was also demonstrated in such apparently suitable toxin-producing media as the dead larvae and pupae of hydrophilid beetles, submerged wheat heads of the season's crop, colonies of dead copepods, and miscellaneous insect débris, drifted ashore by wave and wind action.

This array of demonstrated toxin-producing media, though admittedly only a beginning, already includes food items that would indicate the channels through which ducks and shore birds may contract the trouble. Added research we feel is destined to extend the categories of toxin-producing food items of these two groups of highly susceptible birds and, bit by bit, round out our knowledge of the sources and vehicles for the toxin now known to affect more than sixty species of wild birds.

During 1931, progress also was made in the study of other aspects of this problem. Mentioning only a few, attention may be called to the apparent and doubtless important correlation between the incidence of duck sickness and alkalinity; the presence of Type C to the almost if not total exclusion of other types of botulism in duck sickness environments; the degree of susceptibility of lower organisms, both vertebrate and invertebrate, the death of which in the course of an outbreak of the disease would greatly augment the quantity of toxin-producing media; the toxin-destroying properties of high concentrations of certain alkaline salts and the possibility of thus explaining the absence of duck sickness from certain areas otherwise suited to its occurrence. These and numerous other aspects of the problem, mainly bacteriological in character, bid fair to make future studies of duck sickness of as great importance to the bacteriologist as to the conservationist of wild life.

During the season of 1931 Mr. M. F. Gunderson, employed by the Disease Investigation Project of the Biological Survey, worked with the writer, and to him is due great credit for the progress made along bacteriological and toxicological lines. At present he is continuing these studies in the department of bacteriology and immunology, University of Minnesota. It is a fruitful field for pure research as well as for the attainment of results of great practical value in the preservation of wild birds, and it stands to reason that, before the story of western duck sickness is completed, earlier concepts of the disease as well as the prevalence, range and economic importance of *Clostridium botulinum,* Type C, will be greatly changed.

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Gray, Horace and J. G. Ayres. *Growth in Private School Children.* Pp. xv + 282. University of Chicago Press. $3.50.

International Address Book of Botanists. Pp. xv + 605. Braillière, Tindall and Cox. London. 12s. 6d.

Rorimer, James J. *Ultra-violet Rays and Works of Art.* Pp. xii + 61. 47 plates. The Metropolitan Museum of Art. $2.00.

Schairer, John F. *The Minerals of Connecticut.* Pp. 121 + vii. State Geological and Natural History Survey.