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State of Connecticut

THIRD BIENNIAL REPORT OF THE
COMMISSIONERS

OF THE

State Geological and Natural
History Survey

1907-1908

BULLETIN NO. 12

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State of Connecticut

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State Geological and Natural
History Survey

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WILLIAM NORTH RICE

BULLETIN No. 12



HARTFORD
Published by the State
1908

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THIRD BIENNIAL REPORT OF THE
COMMISSIONERS

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State Geological and Natural History
Survey of Connecticut

1907-1908

PUBLICATION

APPROVED BY

THE BOARD OF CONTROL



HARTFORD
Published by the State
1908

HARTFORD, CONN., December 31, 1908.

HIS EXCELLENCY, ROLLIN S. WOODRUFF, Governor of Connecticut, *Hartford, Connecticut.*

Sir: — I have the honor to transmit to you herewith, in behalf of the Connecticut Geological and Natural History Survey Commission, the report of the Superintendent of the work, covering the period of two years ending December 31, 1908.

Very respectfully,

FLAVEL S. LUTHER,

Secretary of the Commission.

STATE GEOLOGICAL AND NATURAL HISTORY SURVEY

THIRD BIENNIAL REPORT

SCOPE AND PLAN OF THE SURVEY

There has been no change in the general scope and plan of the Survey since its first organization. It may, however, be convenient briefly to recapitulate what has been said thereon in former reports. The Survey was established by an act approved June 3, 1903. That act proposed for the Survey two subjects for investigation; viz., the geology of the state, and the natural history, or botany and zoölogy, of the state. It has been presumed to be the intent of the law that the appropriation should be divided with some approach to equality between geology and biology. The law establishing the Survey proposes definitely three aims with reference to which the work should be prosecuted:—first, the purely scientific aim of advancing our knowledge of the geology and natural history of the state; second, the economic aim of leading to the most effective conservation and utilization of the resources of the state; third, the educational aim of promoting the work of the schools of the state by the publication of the results of investigation in a form adapted for the use of teachers.

The plan of organization which was outlined in the first report has been retained. Only one salaried officer has been appointed by the Commissioners; viz., the Superintendent. Other scientific men have been engaged to investigate particular subjects and prepare reports or bulletins thereon. In the great majority of cases, the terms of contract with these scientific men have been that the investigator should receive a certain sum as compensation when the bulletin presented was accepted by the Superintendent, and that a certain allowance should also be made from the appropriation for the Survey for the expenses of the

work, the allotment for expenses to be drawn upon from time to time as the expenses were actually incurred. This allowance for expenses has been understood to be available for necessary travel, for the employment of stenographic or other clerical assistance, or for the employment of students or scientific men of less experience who could do some part of the work under the direction of the responsible investigator. In some cases, however, this form of contract has been impracticable, as investigations have been commenced and prosecuted in regard to which it could not be foreseen how soon they would result in conclusions definite enough for publication. In such cases the agreement has been to pay the investigator a small sum per diem, a maximum limit being prescribed in every such case.

Each report prepared is published as a separate bulletin, the bulletins being numbered consecutively, generally in the order of time in which they are received. Each bulletin bears the name of the author or the names of the authors, and each author is responsible for his own work. The bulletins are issued in paper covers, but a part of the edition is reserved for binding. Bulletins 1 to 5 have been bound as Vol. I. Bulletins 6 to 11 will be bound at an early date as Vol. II. The bound volumes are especially desirable for public libraries and similar institutions, in which complete sets of our publications are to be preserved. The pamphlet form, in which each bulletin is complete in itself, is convenient for the large number of students, teachers, and others who have use for some particular bulletin. The publications of the Survey are distributed by the State Librarian. They are given liberally to colleges, public libraries, geological surveys, and other scientific institutions, and to scientific men of repute in the branches of science with which the respective bulletins are concerned. In many cases publications of great value are received in exchange for the publications of the Survey. All books and papers thus received are deposited in the State Library. The publications of the Survey are also distributed liberally to citizens of our own state, particularly to teachers who can make use of them in their work. In the case of persons in other states who are not known as scientific men, and who appear to have no special claim for the donation of the publications of the Survey, the bulletins are sold at prices sufficient to cover the cost of printing and transportation.

BULLETINS ALREADY PUBLISHED

The two previous biennial reports of the Commissioners are numbered respectively in the series as 1 and 9.

Four bulletins on scientific subjects were published between the dates of publication of the first and the second biennial report. These were the following:—

No. 2. A Preliminary Report on the Protozoa of the Fresh Waters of Connecticut: by Herbert William Conn.

No. 3. A Preliminary Report on the Hymeniales of Connecticut: by Edward Albert White.

No. 4. The Clays and Clay Industries of Connecticut: by Gerald Francis Loughlin.

No. 5. The Ustilagineæ, or Smuts, of Connecticut: by George Perkins Clinton.

Five bulletins have been published since the presentation of the second biennial report. These are the following:—

No. 6. Manual of the Geology of Connecticut: by William North Rice, Professor of Geology in Wesleyan University, and Herbert Ernest Gregory, Professor of Geology in Yale University.

No. 7. Preliminary Geological Map of Connecticut: by Herbert Ernest Gregory, and Henry Hollister Robinson, Instructor in Geology in Yale University.

No. 8. Bibliography of Connecticut Geology: by Herbert Ernest Gregory.

No. 10. A Preliminary Report on the Algæ of the Fresh Waters of Connecticut: by Herbert William Conn, Professor of Biology in Wesleyan University, and Lucia Washburn (Hazen) Webster.

No. 11. The Bryophytes of Connecticut: by Alexander William Evans, Professor of Botany in Yale University, and George Elwood Nichols, Assistant in Botany in Yale University.

The Manual of Connecticut Geology is the first attempt at a somewhat detailed account of the geology of the entire state since the publication of Percival's report in 1842. It is needless to say that our knowledge of the subject has greatly advanced within the past sixty years. During that time much work has been done in the study of Connecticut geology by officers of the United States Geological Survey and by private individuals, and the general advance of geological science has put a new inter-

pretation upon many facts previously known. But the results of this work, so far as published, were scattered through many volumes of scientific serials and government reports, so as to be well nigh inaccessible to the majority of students and teachers. The publication of the Manual of Geology has accordingly supplied to the teachers and students of our state a long-felt need. The book consists of four chapters:—the first, by Professor Rice, on the physical geography of the state as related to geological structure; the second, by Professor Gregory, on the crystalline rocks; the third, by Professor Rice, on the Triassic sandstones and trap rocks; the fourth, by Professor Gregory, on glacial geology. The work is illustrated with 10 maps, 19 plates from photographs of scenery illustrating geological structure, and numerous diagrams. It has been heartily welcomed by the teachers of the state, who have in some cases purchased considerable numbers of copies for the use of their classes.

The Geological Map of Connecticut is on a scale of four miles to the inch. It has been produced in the best style of chromolithography by Julius Bien & Company. The map shows all the topography which is shown in the State Topographical Map on a scale of two miles to the inch, including the 100-foot contour lines. Roads are indicated by single lines. Notwithstanding the details of topography and culture which are represented on the map, the base map has been made sufficiently clear to show satisfactorily the geological coloring by the omission of all except a few of the most important names. The map has been issued in three different forms:—the first, printed on thin paper, to be folded and inserted in a pocket in the accompanying pamphlet; the second, printed on thick paper; the third, mounted on cloth for use as a wall map. The accompanying pamphlet, besides giving all necessary explanations for the understanding of the map, gives a brief history of geological investigation in the state.

The Bibliography of Connecticut Geology was prepared by Professor Gregory for his own use in investigation and teaching. It was recognized by the Superintendent of the Survey that such a work would be of great utility to all students and teachers of the geology of the state, and Professor Gregory generously gave his manuscript to the Survey without any compensation. It gives not only titles, but brief analyses of the contents, and

in some cases brief criticisms, of publications relating to Connecticut geology, whether appearing as independent works, or as articles in government reports or in periodicals. Mention is also made of maps showing the geology of the entire state or of parts of the state. The work will certainly be of great value to all students of Connecticut geology.

The Report on the Fresh-water Algæ, by Professor Conn and Mrs. Webster, is a companion work to Professor Conn's report on the fresh-water protozoa which was published as Bulletin No. 2. Together they constitute a partial fulfillment of the plan which was formed in the inception of the Survey, of making a thorough study of the microscopic life of our fresh waters. It was believed that such a study, apart from its scientific and educational value, might perhaps develop important results in reference to the reservoirs and other water supplies for drinking purposes. In the present report on the Algæ, analytical keys to genera and species are given, and the species which have been observed are represented in 45 plates, including 291 figures. Most of these figures are from drawings by Mrs. Webster. A few of them are by Professor Conn. They are exceedingly beautiful, and will be found very helpful by all students of this interesting group of organisms.

The report on the Bryophytes of Connecticut, by Professor Evans and Mr. Nichols, deals with a group of plants of great interest to the student of vegetable morphology and evolution, and not destitute of important economic relations, but a group which until recently has been almost entirely neglected by students and collectors of the plants of the state. The group includes the plants commonly known as mosses and liverworts. The present report is not illustrated; and is not intended to replace, but rather to supplement, the works which have been published, some of which are sufficiently accessible, on the systematic botany of the group. Analytical keys are given, affording a diagnosis of all the genera and species known to occur in the state. In connection with each species are given the names of all the towns in which the species have been observed and the names of the botanists by whom the specimens have been collected, together with the date of its first discovery in the state. The book affords thus a history of the study of a comparatively neglected group in the state. The special account of the Bryo-

phytes of Connecticut is preceded by chapters on the general characters of the class, the distribution of the species with reference to topography, climate, and geological structure, and the economic relations of the plants, and is followed by a very full bibliography.

BULLETINS ACCEPTED FOR PUBLICATION

The following bulletins have been accepted for publication:—

The Lithology of Connecticut: by Joseph Barrell, Professor of Geology in Yale University, and Gerald Francis Loughlin, Instructor in Geology in Massachusetts Institute of Technology.

The Flowering Plants and Pteridophytes of Connecticut: by a Committee of the Connecticut Botanical Society.

Second Report on the Hymeniales of Connecticut: by Edward Albert White, Assistant Professor of Floriculture in the Massachusetts Agricultural College.

The Triassic Fishes of Connecticut: by Charles Rochester Eastman, Curator of Vertebrate Paleontology in the Museum of Comparative Zoölogy, Harvard University.

The Insects of Connecticut, Parts 1 and 2: prepared under the direction of Wilton Everett Britton, Entomologist of the Connecticut Agricultural Experiment Station.

The bulletin on the Lithology of Connecticut contains a general introduction to lithology by Professor Barrell, and a special description of forty-one typical rocks from Connecticut localities by Dr. Loughlin. In the general part of the work, lithology is treated in relation to mineralogy and dynamical geology, so that the student may learn somewhat of the agencies by which the different types of rocks are produced, as well as their composition and characteristic aspect. Both in the general and the special part of the work attention is given chiefly to those characteristics of rocks which can be recognized by the naked eye or by the simple microscope, with comparatively little reference to the phenomena which can be observed only by the examination of thin sections under the compound polarizing microscope. This limitation of the discussion for the most part to characters observable by the naked eye renders the work adapted to the use of comparatively elementary students. The usefulness of the work in the high schools and other institutions in the state will

be greatly enhanced by the distribution to those institutions of suites of specimens of rocks from the typical localities described in the special part of the paper. These specimens were for the most part collected in the summers of 1905 and 1906. They will be distributed, as soon as the bulletin is published, to colleges, normal schools, high schools, and academies in the state, on condition that the institution shall pay the cost of transportation. Any suites of specimens remaining in the possession of the Survey after such distribution may be sold and the money paid into the treasury of the state.

The work of the Connecticut Botanical Society on the Flowering Plants and Pteridophytes of the state will be, particularly from an educational point of view, one of the most important bulletins of the Survey. The Connecticut Botanical Society, including a considerable number of enthusiastic botanists, professional and amateur, have been engaged for a considerable time in collecting material for a Flora of the State. Soon after the inception of the State Survey, the Connecticut Botanical Society acceded to the invitation of the Superintendent of the Survey, to furnish their work when completed for publication as a bulletin of the Survey. The Committee in charge of the work have given their services gratuitously, the Survey making only an allowance for necessary expenses. The bulletin gives a complete list of the plants known to occur in the State, arranged according to the classification adopted in the seventh edition of Gray's Manual of Botany, edited by Robinson and Fernald. In connection with each species, notes are given in regard to its geographical and topographical distribution. Special attention is naturally given to rare plants and to those plants the limit of whose range lies in or near our territory. Notice is also given of the economic relations of all plants which are in marked degree useful or injurious. In this work analytical keys and descriptions of genera and species are not given, since they can be found in Gray's Manual and other readily accessible books.

The Second Report on the Hymeniales, by Professor White, is chiefly occupied with a more detailed account of the family Agaricaceæ. This is the most important family of the Hymeniales, including a number of edible mushrooms and also some poisonous species. Besides giving a detailed account of this family, the paper will give a supplementary list of the species

of other families of Hymeniales which have been discovered in the state since the publication of the first report.

The bulletin on the Triassic Fishes, by Dr. Eastman, is a very important contribution to the paleontology of the state. The area of Connecticut is by no means rich in fossils. The crystalline rocks of the eastern and western highlands have proved as yet utterly barren of fossils. Whatever fossils some of these rocks may have once contained have been entirely obliterated by the processes of metamorphism. The Triassic formation of the Connecticut Valley has afforded scarcely any fossils, excepting tracks of reptiles and amphibians on some of the beds, and remains of fishes in two or three thin strata of black shale intercalated among the red sandstones. The scantiness of fossils in this formation has made difficult the determination of its geological age. Dr. Eastman has made a very careful study of all the important collections of the fossil fishes of this formation. He has been able thus to make a more exact determination of some features of the anatomy of the animals than has been made before. He has also made comparisons of the fish fauna of our Connecticut beds with the fish faunas of other Triassic formations in various parts of the world. This comparison leads him to the opinion that the age of our Connecticut formation corresponds most nearly, not with the uppermost European Trias (Keuper or Rhætic), but rather with a somewhat lower horizon, near the boundary between the Muschelkalk and the Keuper.

The bulletin on the Insects of Connecticut forms the beginning of a series of papers on that group of animals, whose publication may be distributed through a considerable number of years. It is needless to comment on the immense economic importance of the class of insects, many insects being the worst enemies of our agricultural interests, while others, insectivorous or parasitic in habit, tend to hold in check the destroyers of agricultural products. Two parts of the work have thus far been accepted for publication. Part 1 is a general outline of the character and relations of the class, by Dr. Britton, who is to act also as general editor of the whole series of papers on insects. Part 2 is a special discussion of the Orthoptera of Connecticut, by Benjamin Hovey Walden, Assistant in Entomology in Connecticut Agricultural Experiment Station. The mere mention of the words locust and grasshopper is enough to suggest the

importance of the economic relations of the orthoptera. These papers will be illustrated by a number of plates showing photographic representations of entire insects, and by drawings of diagnostic parts of the anatomy of the various groups.

WORK STILL IN PROGRESS

I. Geology

The geological investigations now in progress relate chiefly to surface geology, or the study of the phenomena connected with the work of the great ice sheet of the Glacial period. For more than a generation geologists have recognized that the mantle of heterogeneous and unstratified drift covering most of New England and the adjacent country is essentially the ground moraine of a continental glacier; that the widely scattered smooth, polished, and striated rock surfaces are the result of erosion by such a continental glacier; and that the stratified deposits in the river valleys consist of the débris transported by the glacier, sorted and redistributed by the action of water. But it is within a comparatively few years that a more thorough and detailed study has been given to these glacial phenomena. Of the comparatively small amount of study that has been given to the glacial geology of Connecticut, a considerable part has been vitiated by preconceptions now known to be erroneous, leading to false interpretations of observed facts, and preventing due appreciation of phenomena which might have been observed. There is need of a large amount of new study before the true history of the glacial and aqueo-glacial formations of the state can be determined.

Dr. F. P. Gulliver of Norwich has been at work for some time on a detailed study of the terraces bordering the estuary of the Thames. These shelves of stratified sand and gravel at a considerable elevation above the present level of the river have been supposed to be remnants of a great sand and gravel plain which was once substantially continuous across the valley, and which was formed, after the retreat of the ice from the portion of the valley in question, by deposition in the waters of the river, whose velocity was at that time feeble by reason of diminished slope and excessive load of sediment. A number of years

ago Dr. Gulliver published a preliminary paper on the terraces of the Thames, in which he gave reasons for the belief that those terraces were formed on the edges of the valley while a tongue of ice still lingered in the central part. Various students have shown reasons for a similar belief as regards the terraces in the lower or estuarine portions of other rivers of the North Atlantic slope. The study of these terraces is therefore of great interest in the endeavor to trace out the detailed history of the later stages of the ice age. Dr. Gulliver has accordingly undertaken to make a more detailed survey of the terraces of the Thames River, and to furnish the result for publication as a bulletin of the State Survey.

Numerous other problems present themselves in the detailed study of the glacial geology of this region. Studies of the glacial formations in the Mississippi Valley, in northern Europe, and in the Alpine region, have clearly revealed the fact that the Glacial period was more complex than was formerly supposed. There were repeated alternations of rigor and mildness in the climate, in accordance with which the great ice sheets alternately advanced and retreated. The deposits of earlier ice sheets can be recognized in some regions, emerging from beneath the edge of the later deposits, while in some localities stratified and fossiliferous interglacial deposits can be recognized between the older and the younger glacial formations. In New England the latest advance of the ice sheet extended beyond the shore line, and it has been generally supposed that the latest ice invasion so thoroughly disturbed all deposits of the earlier ice sheets, as to leave no recognizable remains of them. There is need, however, of thorough study of precisely this question. There is need also of careful examination for the purpose of tracing in more detail the history of successive stages in the final recession of the ice sheet. During the summer of 1907 Professor H. E. Gregory devoted considerable time to field work in the study of the Glacial formations of the state. As a preliminary result of this study, a bulletin on the Glacial phenomena of the Naugatuck Valley will be ready at an early date. In the Geological Map of Connecticut, which was published as Bulletin No. 7, surface geology was entirely ignored, the map representing only the bed rocks which lie beneath the mantle of drift. It is expected that Professor Gregory's work

will result eventually in the preparation of another general map of the state showing the surface geology, and a volume of text tracing with some approach to completeness the history of the Glacial period in our state.

The melting away of the great ice sheet left the surface of Connecticut and of the adjacent country dotted with innumerable lakes and ponds, many of which have already become obliterated. One of the processes which have led to the disappearance of these ponds is the accumulation of the débris of vegetation, converting the ponds into peat bogs. The peat is not only of great scientific interest, both to the geologist and to the botanist, but possesses considerable economic importance, having uses as a fuel and as a fertilizer, and being capable also incidentally of employment for various other purposes. Attention has recently been called to the economic value of peat by the investigations of the United States Geological Survey, which have shown its special fitness for use in the gas-producer. It was, therefore, deemed desirable to make a special investigation of the peat deposits of Connecticut, and this was rendered practicable by the generous coöperation of the United States Geological Survey. During the summer of 1907 the field work of the investigation was substantially accomplished. The localities of all the important peat bogs of the state were visited, the area of those bogs was noted, their depth was determined by a sounding apparatus, and samples for analysis were collected from various depths. This work was accomplished by Messrs. E. C. Miller, A.B., and T. T. Giffen, A.B., of Yale University. Professor C. A. Davis of the University of Michigan, who was employed by the United States Geological Survey in the summer of 1907 for a reconnoissance of the peat deposits of the Atlantic border of the country from Maine to Florida, was permitted by the courtesy of the United States Geological Survey to spend a few days in Connecticut at the beginning of the season of field work. He was able, therefore, to give Messrs. Miller and Giffen the necessary instruction in regard to methods of work. The bulletin which will be published will contain a general paper on the scientific and economic relations of peat, by Professor Davis, who has made himself eminently an authority on the subject. It will also contain the notes of Messrs. Miller and Giffen in regard to their field work. A selection of samples collected by Messrs. Miller and Giffen have been analyzed in the laboratory of the United States Geological Survey, and reports of those analyses will be

included in the bulletin. The State Survey is very greatly indebted to the liberality of the United States Geological Survey for the all-important assistance of Professor Davis at the beginning of the investigation, and for the analyses made in the laboratory of the United States Geological Survey.

II. Botany

Dr. G. P. Clinton of the Connecticut Agricultural Experiment Station, whose paper on the smuts was published as Bulletin No. 5, is at work on another important group of parasitic fungi, viz., the downy mildews. This group includes a number of parasites destructive to important agricultural products, and the bulletin will be therefore an important contribution to the economic botany of the State.

Professor Conn, whose work on the protozoa and algæ of the fresh waters of Connecticut has been published as Bulletins 2 and 10, is continuing his study of the microscopic life of the fresh waters by an investigation of the bacteria. The relation of bacteria to public health is so well understood as to make it obvious that a study of the distribution of bacteria in the reservoirs and other sources of drinking water must be of great importance from a practical as well as from a purely scientific point of view. A preliminary report on the bacteria will be presented at an early date.

III. Zoölogy

Mr. John H. Sage of Portland and Dr. Louis B. Bishop of New Haven are still at work upon their bulletin on the birds of Connecticut. It will contain a vast amount of information in regard to the dates of arrival and departure of our migratory birds, the localities of rare birds, and the food and habits of the birds. This bulletin will be of interest not only to ornithologists but also to teachers and farmers. It will tend to correct some erroneous impressions which are prevalent in regard to the relation of some birds to agricultural interests. Some of the birds of prey, for instance, which are commonly regarded as the farmer's foes, are really the farmer's friends. In fact, the sharp-shinned hawk, Cooper's hawk, and the great horned owl are probably the only birds of prey that are in any considerable degree injurious to agriculture in Connecticut.

As stated above, two parts of a work on the insects of Con-

necticut, prepared under the direction of W. E. Britton, have been already accepted for publication. Part third, relating to the hymenoptera, is nearly completed. This part is by Mr. Henry L. Viereck, formerly of the Connecticut Agricultural Experiment Station. The hymenoptera, including the bees, wasps, ants, and saw-flies, are a group of great interest from an economic as well as from a purely scientific point of view, many of them being eminently useful and others decidedly injurious to agriculture.

A bulletin on the echinodermata of Connecticut, by Professor W. R. Coe of Yale University, is nearly ready. The starfishes, which are among the best-known representatives of this group, occasion a very serious loss to the resources of the state by the ravages which they make in oyster beds. Professor Coe has given much attention in this bulletin to the economic relations of the group. The paper will be beautifully illustrated, and will be of much use to the teachers of natural history in the schools.

DISTRIBUTION OF THE APPROPRIATIONS

The expenditures for work which has been completed and for which full payment has been made since the last biennial report have been as follows:—

Name	Work	Compensation	Expenses
W. N. Rice	Superintendence, 1905-7	\$400	\$256.49
H. W. Conn	Fresh-water Algæ	150	250.00
A. W. Evans and G. E. Nichols	Bryophytes	100	50.00
J. Barrell and G. F. Loughlin	Lithology	150	550.00*

The allotments for work which is still in progress, or for which full payment has not been made, are as follows:—

Name	Work	Compensation	Expenses
W. N. Rice	Superintendence, 1907-9	\$400	\$300
F. P. Gulliver	Thames River Terraces	171	154
H. E. Gregory	Quaternary Geology	900†	
C. R. Eastman	Triassic Fishes	300	100
C. A. Davis, T. T. Giffen, and E. C. Miller	Peat	329	320

*The exceptionally large allowance for expenses provided for the collection of suites of specimens for distribution.

†This investigation requires a very large amount of field work.

Name	Work	Compensation	Expenses
Conn. Botanical Society	Flowering Plants and Pteridophytes		300
G. P. Clinton	Downy Mildews	50	25
E. A. White	Fungi	100	75
H. W. Conn	Fresh-water Bacteria	200	250
J. H. Sage and L. B. Bishop	Birds	200	200
W. R. Coe	Echinoderms	75	25
W. E. Britton	Insects	125	125

The smallness of the compensation, in comparison with the grade of ability of the workers, the amount of the work, and the value of the results, is very noticeable.

PLANS FOR FUTURE WORK

I. Geology

It may be said in general that there is need of more detailed study in most parts of the state than has yet been accomplished. Apart from the problems of surface geology, the area of the state most thoroughly studied is that of the Triassic formation. The area where detailed work is most lacking as yet is that of the eastern crystallines. The geological work which has been done in much of eastern Connecticut amounts to little more than a reconnoissance. The Manual of Geology, and the Geological Map by which it is supplemented, bear most eminently the character not of final reports, but of reports of progress. Their publication was amply justified by the need, on the part of teachers and others, for publications which would set forth in convenient and intelligible form our present knowledge of the geology of the state. But they certainly will require very much of correction in detail. It is, moreover, not unlikely that more detailed study will bring to light facts which will lead to very important changes in the general conception of the geological history which is recorded in our rocks.

The necessity for more detailed study in various parts of the state is even greater in regard to surface geology than in regard to the geology of the underlying rocks. Professor Gregory has made a beginning of such investigation; but a vast amount of careful work must be done before we can reach the true history of the Quaternary era in our territory.

A report on the mineralogy of our state would be very useful. Lists of American localities of minerals have been published in

a number of editions of the works of J. D. and E. S. Dana on mineralogy, the latest being in the sixth edition of the System of Mineralogy, published in 1892. A list of Connecticut minerals by Hattie E. Cochrane, dated 1894, is contained in the Report of the State Board of Education for 1896. Neither of these lists is by any means complete. Moreover, a report of the mineralogy of the state should be much more than a mere list of minerals occurring in the respective towns. Such a report should give more detailed information in regard to localities of interesting and important minerals, and should enter into some discussion of the geological relations of the minerals.

Among the bulletins already accepted for publication, is one on the Triassic fishes by Dr. Eastman. Besides these fishes, the Triassic rocks afford another interesting class of fossils; namely, the tracks of various animals, chiefly reptiles and amphibians. A future bulletin should be devoted to a revision of these tracks.

In the introductory chapter of the Manual of Connecticut Geology is found a brief discussion of the physical geography of the state in relation to geological structure. A subject whose treatment in a bulletin or in a series of bulletins would be of great educational value, would be the physical geography of various parts of the state, particularly in relation to human life and history. In such publications the influence of geographic conditions in the location of towns, in the determination of routes of travel, and in the control of the industries of the state, should be discussed. Such bulletin or bulletins on the physical geography of the state would be of great interest to all intelligent citizens, and particularly to the teachers in our schools.

II. Botany

The labors of the Connecticut Botanical Society have given to us a list of the flowering plants of the state, and of the ferns and their allies. This paper will afford much information in regard to the geographical and topographical distribution of particular species of plants. An appropriate line of investigation, and one in regard to which it may be hoped that the Survey may be able to publish important papers in the future, would be the more extended study of the distribution of plants with reference to altitude, geological formation, distance from the sea, temperature, and rainfall, and the grouping of plants into plant societies

in different areas — in short, the study of what is now called the ecology of plants.

The systematic botany of the flowering plants has been comparatively well worked out for this region of country. Much less has been done in regard to the flowerless plants, and particularly in regard to the lower classes of flowerless plants. The paper of Professor Evans and Mr. Nichols on the mosses and liverworts, those of Professor White on the larger fungi, those of Dr. Clinton on the microscopic fungi, and that of Professor Conn and Mrs. Webster on the fresh-water algæ, are a good beginning in this direction. But there are a number of groups of the lower flowerless plants for whose study very little material is accessible to students or even to teachers in Connecticut. Interesting groups which should be treated in future bulletins of the Survey are the lichens and the marine algæ.

III. Zoölogy

Professor Conn's paper on the protozoa makes a good beginning of the study of the life of our fresh waters. In future years attention should be given to other groups of fresh-water organisms; for instance, the mollusks, worms, crustacea, and fishes.

No general work dealing with the marine fauna of the Connecticut coast has been published since the very valuable paper by Verrill and Smith on the Invertebrate Animals of Vineyard Sound, published in the Report of the United States Commissioner of Fish and Fisheries for 1871-2.* The State Survey should publish a series of bulletins on the various groups of marine organisms. Some of these papers would be of very great educational value, while some of them would be important from an economic point of view, since our marine fauna includes some species which are among the important resources of the state, and other species which are destructive of important resources.

Two orders of insects have been treated in parts 2 and 3 of the work under the direction of Dr. Britton, one of which has been already accepted for publication, and the other of which is nearly ready. Several other orders of insects, however, are much more numerous in species than the ones already treated,

* Most of the animals living in Long Island Sound and Fisher's Island Sound are included in the fauna of Vineyard Sound.

and include a larger number of forms of economic importance. The completion of the proposed work on the insects of the state must require the labor of years.

THE NEED OF FURTHER APPROPRIATIONS

What has already been said in regard to the work accomplished or in progress and the plans for future work, makes it obvious that the business of the State Geological and Natural History Survey is not rapidly approaching completion. In fact, the State Survey should be recognized as a permanent institution. The Geological Survey of the state of New York was commenced in 1836. There is at present no organization in the state of New York bearing the title of Geological Survey, but there is a State Geologist who forms a member of the staff of the Science Division of the Education Department of the state. Under one form of organization or another, the work of geological investigation under the auspices of the state of New York has already been substantially continuous for more than two generations. There is no prospect that it will ever be finished.

In a number of states, indeed, Geological Surveys have been organized, prosecuted for a few years, and concluded by the publication of so-called final reports. But there can be no final report on the geology, the botany, or the zoölogy of any district of country. In those states whose Geological Surveys have published what have been called final reports, enlightened citizens and legislators have sooner or later come to see the necessity for organizing a second Survey and doing the work over again. The sciences of nature are progressive; new discoveries from time to time put old facts in new relations, and raise new questions whose answer requires new methods of investigation. There are changes also in the arts which depend upon the application of the sciences, as well as in the sciences themselves. New forms of raw material become valuable, new modes of utilizing well-known materials become practicable. On the economic side, as well as on the purely scientific side, arises a necessity that the work of a Survey which had been supposed to be completed should be done over again.

If a State Survey is recognized as a permanent bureau, it can publish, from time to time, supplementary reports correcting and amplifying its previous work as may be necessary. It can

be ready also to give attention to particular investigations which may have a special importance, for economic or other reasons, at some particular time. Moreover, the work of a Geological and Natural History Survey can be carried on much more economically by the plan of small appropriations maintaining a permanent organization, than by the plan of attempting to complete the work in a few years and then doing it over again a generation later. The experience of our Connecticut Survey illustrates well the economy of this method of procedure. Field work can be done in the summer vacations by college professors, teachers, and others who are willing to do a certain amount of such work for very small compensation. Investigations can be made and bulletins can be written in large degree in odds and ends of time, by men who receive salaries for work in the colleges and other institutions of learning, or in museums and other scientific institutions. Under such conditions men of a high grade of ability and attainment are willing to offer for publication the result of their investigations for merely nominal compensation. The amount of valuable material already published, and the amount which is ready or nearly ready for publication, by our Survey, in comparison with the very small cost, is a striking illustration of the economy of this method of procedure. If, on the other hand, the work of a Survey is to be completed, and final reports presented in a few years, it is generally necessary that a number of competent men should be employed to give practically their whole time to the work. They must be paid salaries which will justify them in resigning any official positions which they may hold and taking their chances of securing other employment when the work of the Survey is finished.

If the State Geological and Natural History Survey is recognized as a permanent institution, it is not important that its annual appropriation should be largely increased. Our annual appropriation is certainly one of the smallest, if not absolutely the smallest annual appropriation afforded at the present time by any state which maintains a Geological or Natural History Survey. Several of the states have been making, year after year, an appropriation of \$10,000 for geology alone, in comparison with which our appropriation of \$1,500 a year for geology, botany, and zoölogy seems pretty small. In the states referred to, this large appropriation for geological work is exclusive of

the cost of publication, as is the case with our own appropriation. If, in its wisdom, the General Assembly is disposed slightly to increase the appropriation for the State Survey, we will undertake to make good use of the additional money; but we are not disposed strenuously to urge an increased appropriation. If the Survey can be recognized as a permanent institution and the same annual appropriation can be assured, and if adequate provision can be made for the publication of the results of the Survey, the conditions for the work of some years in the immediate future will be satisfactory.

LEGISLATION DESIRED IN REGARD TO PUBLICATION OF BULLETINS

The law establishing the Survey made it the duty of the Commissioners to cause to be prepared a report to the General Assembly before each meeting of the same, and special reports, with necessary illustrations and maps, on the geology and natural history of the state. It also made it the duty of the Commissioners to direct in regard to the sale or distribution of the reports, when printed. It imposed upon the Commissioners no responsibility for the printing. It was the obvious intent of the act that the whole of the small appropriation made for the Survey should be devoted to the scientific work of investigation and preparation of the reports. The cost of publication of the reports was to come out of the general funds in the treasury of the state. When the first bulletin of the Survey came to be printed, an unexpected difficulty appeared. The general law in regard to the state printing provides for the printing of not more than 1,575 copies of any official report. But such an edition is utterly inadequate for the bulletins in the Survey. It is desired that these bulletins should be, as is customary in the case of similar publications in other states, widely distributed to colleges, scientific institutions, public libraries, scientific men, teachers, and others. The editions of similar reports published by other states generally range from 3,000 to 8,000. It is obviously useless to prepare elaborate scientific reports, and then print so small an edition as to render it impossible for those reports to reach the persons who would desire to use them. Hence the necessity for some action of the General Assembly to provide for the printing of the bulletins of the Survey.

At the session of the General Assembly in 1905, the matter

was dealt with for the time being by a resolution authorizing the printing of the desired numbers of copies of certain specified bulletins, and of such others, not exceeding thirteen in number, as might be ready for printing before January 1, 1907. Under this authorization Bulletins 1 to 9 were printed.

At the session of 1907, the General Assembly adopted a resolution authorizing the Comptroller "to have printed, in lieu of the number of copies authorized by the general statutes relating to public documents, 3,000 copies of the regular and special reports of the State Geological and Natural History Survey, and, in addition to the number hereinbefore specified, such number of any of the special reports of said Survey as may be requested by the Commissioners of said Survey and approved by the Board of Control; provided, that the total number of copies of any report so printed shall in no case exceed 4,500." The second section of the resolution appropriated the sum of \$5,000, for the two fiscal years ending September 30, 1909, "in full compensation for the purposes of this resolution." There has been some doubt in regard to the intent of the second section. Was that \$5,000 appropriated to cover the entire expense of the publication of all bulletins which should be printed prior to September 30, 1909? or was that \$5,000 appropriated to provide for the printing of the numbers of copies in excess of the number of copies of public documents authorized by the general law? No legislation was needed to authorize the printing of 1,575 copies of each of the reports, since that was made the duty of the Comptroller by the original act. Special legislation was required only to authorize the printing of the number of copies called for in excess of the number specified in the general law. The Board of Control, doubtless wisely, adopted the more conservative construction of the resolution, holding that the \$5,000 appropriated in the second section of that resolution must cover the entire cost of publication of bulletins of the Survey which should be printed prior to September 30, 1909. Bulletins 10 and 11 have been printed; and the Board of Control has authorized the printing of the bulletin by Professor Barrell and Dr. Loughlin on the Lithology of Connecticut, and the bulletin of the Connecticut Botanical Society on Flowering Plants and Pteridophytes of Connecticut. But these bulletins will so nearly exhaust the \$5,000 appropriated that no other bulletins can be printed until some additional action is taken by the General Assembly. Several bulletins containing

the results of important investigations have been accepted for publication, but must remain unpublished until some action is taken by the General Assembly. The bulletins whose publication is thus deferred are the following: Second Report on the Hymeniales, by Professor E. A. White; The Triassic Fishes of Connecticut, by Dr. C. R. Eastman; and Parts I. and II. of the work on the Insects of Connecticut, prepared under the direction of W. E. Britton. A number of other bulletins are nearly ready, and will doubtless be presented to the Superintendent within the next few months. It is certainly to be greatly regretted that the publication of these valuable bulletins should be delayed by the lack of authorization to print them.

In the resolution passed by the General Assembly in 1907, it was assumed that the minimum number of copies of any bulletin would be 3,000, and that a larger number of copies would be required for some of the bulletins. From what has already been said in regard to the bulletins which have been accepted for publication, or which are in an advanced stage of preparation, it will be obvious that some of them are of a more popular character than others, and will appeal to a wider constituency of readers. The respective numbers of copies deemed necessary to meet the demand which may be reasonably anticipated in the case of the bulletins already accepted for publication but not yet ordered by the Board of Control to be printed, and of those bulletins which are approaching completion and which may be expected to be ready for publication within a few months, are shown in the following table:—

Author	Subject	No. of Copies
F. P. Gulliver	Thames River Terraces	3000
H. E. Gregory	Quaternary Geology of Naugatuck Valley	3500
C. R. Eastman	Triassic Fishes	3500
C. A. Davis and others	Peat	4000
G. P. Clinton	Downy Mildews	3000
E. A. White	Fungi	3500
H. W. Conn	Fresh-water Bacteria	3500
J. H. Sage and L. B. Bishop	Birds	4500
W. R. Coe	Echinoderms	3500
W. E. Britton	Insects	3500

We accordingly earnestly petition the General Assembly either specifically to authorize the printing of the number of copies above specified in the case of each of the forthcoming bulletins, or to pass a resolution authorizing the printing of such editions of the respective bulletins, not exceeding 4,500 in any case, as may be recommended by the Board of Commissioners and approved by the Board of Control.

Attention has already been called to the large amount of valuable scientific work which the Survey has produced at very small cost. Scientific men in our own state, and even outside of our state, have been willing to contribute to the Survey bulletins containing the result of years of study, for merely nominal compensation. The work of the scientific men in the Survey has been truly a labor of love. But the printers cannot be expected to work for love. They must be paid. And we earnestly appeal to the General Assembly for generous action in regard to the publication of the bulletins of the Survey, that the labors of the scientific workers may not be rendered useless by failure to authorize their publication.

THE TOPOGRAPHICAL ATLAS OF CONNECTICUT

In addition to the regular work of the Survey, the last General Assembly imposed one special duty upon the Commissioners of the State Geological and Natural History Survey. The supply of bound copies of the Topographical Atlas of the state, in the office of the State Librarian, is now nearly exhausted. There is a steady demand on the part of citizens of the state for the purchase of bound copies of the atlas, as well as for the purchase of separate topographic sheets. On recommendation of the State Librarian, the General Assembly at its last session instructed the Commissioners of the State Survey to procure from the Director of the United States Geological Survey 500 copies of the sheets of the Topographical Atlas of Connecticut, and to cause the same to be suitably bound. A subsequent section of the resolution appropriated the sum of \$1,000 for this specific purpose.

At the time this resolution was passed it was hoped that some revision might be made in the sheets to be purchased from the United States Geological Survey. There are some inaccuracies and a few glaring errors in those topographic sheets as originally

published. Since the publication of those maps there have been some changes in the lay-out of railroads and highways in different parts of the state, and some changes in town boundaries. The inter-urban electric railways have come to be a very important feature in the life of the state. It was hoped that we might be able to secure from the United States Geological Survey a more or less thorough revision of the plates before the printing of the 500 copies which it was proposed to purchase.

It appeared, however, on correspondence with the Director of the United States Geological Survey that such revision would be impracticable. The state of the case is set forth in the following extract from the letter of George Otis Smith, Ph.D., Director of the United States Geological Survey:—

“The whole proposition would be altogether desirable, provided we had the means with which to carry it out. There is need of some legislation whereby the Engraving Division of the Survey may furnish any State Survey with reprints of our maps in whatever form desired, at actual cost; but under the present statute, while such outside work is permissible, it is not practicable, inasmuch as all work of this kind reduces just so much the new work of engraving and printing. When over 60 per cent. of the area of the United States is without any topographic map, I hesitate to expend much money in bringing up to date the sheets earlier issued by the Survey. I think you will not fail to appreciate my feeling that additional work in Connecticut, which has been completely mapped, must take second place to mapping work in Mississippi, of which only 2 per cent. has been covered.”

It appears, accordingly, that any revision of the topographic sheets is out of the question until some new legislation on the part of Congress may make it possible for a revision of the old topographic maps to be made by some form of coöperation between the national and the state authorities. In the meanwhile, it appears that there remains at present in the office of the State Librarian a small supply of unbound copies of the topographical sheets of the special uniform edition printed for the state in 1893. It seems therefore the wisest plan simply to bind up 250 copies of the sheets now on hand. This number of bound atlases will meet any demand which may reasonably be expected for the next few years. In case the supply of any particular sheet in the office of

the State Librarian should be exhausted, additional copies can from time to time be obtained from the Director of the United States Geological Survey, under the ordinary terms of sale, without any special arrangement. Such copies will not be quite uniform in style with the state edition, but for purchasers of separate sheets the lack of uniformity will not be objectionable.

The binding of 250 copies of the sheets now on hand will, of course, require the expenditure of only a small part of the \$1,000 appropriated for the purpose of the topographic atlas, and the remainder of the amount can be returned into the treasury of the state.