

State of Connecticut

SEVENTH BIENNIAL REPORT OF THE
COMMISSIONERS

OF THE

State Geological and Natural
History Survey

1915-1916

BULLETIN No. 27

State of Connecticut

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History Survey

HERBERT E. GREGORY, SUPERINTENDENT

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HARTFORD

Printed for the State Geological and Natural History Survey

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State Geological and Natural History Survey

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SEVENTH BIENNIAL REPORT OF THE COMMISSIONERS

OF THE

State Geological and Natural History Survey of Connecticut

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LETTER OF TRANSMITTAL.

HARTFORD, CONN., December 30, 1916.

HIS EXCELLENCY, MARCUS H. HOLCOMB,
Governor of Connecticut.
Hartford, Connecticut.

Sir:— I have the honor to transmit to you herewith, in behalf of the Commissioners of the State Geological and Natural History Survey, the report of the Superintendent of the work, covering the two years ending December 31, 1916.

Very respectfully,

FLAVEL S. LUTHER,
Secretary of the Commission.

SEVENTH BIENNIAL REPORT OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF CONNECTICUT

RETIREMENT OF PROFESSOR RICE.

At the meeting of the Commissioners, July 1, 1916, the resignation of William North Rice, Superintendent, was accepted, and Herbert E. Gregory was appointed as his successor. Professor Rice assumed the duties of the superintendency with the establishment of the Survey in 1903, adding the responsibilities of this office to those of an active professorship, and during the past thirteen years has rendered unusually valuable services to the State. The preliminary organization of the Survey and its guidance during the early years of its life have required exceptional qualifications. The scope of the work is large and the appropriations have been small. An intimate knowledge of the educational and economic needs of Connecticut, as well as broad scientific attainments, has been essential. The unselfish personality of Professor Rice and his devotion to the work of the Survey have enabled him to attract coworkers. On this the success of the organization has depended; its work has been done by a group of scientific men who were willing to devote part of their energies to the preparation of bulletins practically without financial compensation. Professor Rice has made friends for himself and friends for the Survey both within and without the State and set a high standard of work which the present Superintendent will endeavor to maintain. The enduring value of Professor Rice's work is expressed in the bulletins published. They bear the names of authorities in geology and natural history; the material which they contain is widely used by scientific workers; they show an unusually high standard of editorial excellence; they have a recognized place of usefulness in the educational equipment of Connecticut.

SCOPE AND PLAN OF THE STATE SURVEY.

The act of 1903 establishing the Survey proposed 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 further specifies 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.

It will be appropriate to outline briefly the plans adopted for the carrying out of these objects, and the work which has been already accomplished, or which is in progress.

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 for the expenses of the work, the allotment for expenses to be drawn upon from time to time as the expenses were actually incurred. 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 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 Volume I, Bulletins 6 to 12 as Volume II, Bulletins 13 to 15 as Volume III, and Bulletins 16 to 21 as Volume IV. 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 books and papers 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 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 Survey has already published the following bulletins:

1. First Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1903-1904.
2. A Preliminary Report on the Protozoa of the Fresh Waters of Connecticut, by H. W. Conn.
3. A Preliminary Report on the Hymeniales of Connecticut, by E. A. White.
4. The Clays and Clay Industries of Connecticut, by G. F. Loughlin.
5. The Ustilagineae, or Smuts, of Connecticut, by G. P. Clinton.
6. Manual of the Geology of Connecticut, by W. N. Rice and H. E. Gregory.
7. Preliminary Geological Map of Connecticut, by H. E. Gregory and H. H. Robinson.
8. Bibliography of Connecticut Geology, by H. E. Gregory.
9. Second Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1905-1906.
10. A Preliminary Report on the Algae of the Fresh Waters of Connecticut: by H. W. Conn and L. W. (Hazen) Webster.
11. The Bryophytes of Connecticut, by A. W. Evans and G. E. Nichols.
12. Third Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1907-1908.
13. The Lithology of Connecticut, by Joseph Barrell and G. F. Loughlin.
14. Catalogue of the Flowering Plants and Ferns of Connecticut growing without cultivation, by a Committee of the Connecticut Botanical Society.
15. Second report of the Hymeniales of Connecticut, by E. A. White.
16. Guide to the Insects of Connecticut, prepared under the direction of W. E. Britton. Part I, General Introduction, by

W. E. Britton. Part II, The Euplexoptera and Orthoptera of Connecticut, by B. H. Walden.

17. Fourth Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1909-1910.

18. Triassic Fishes of Connecticut, by C. R. Eastman.

19. Echinoderms of Connecticut, by W. R. Coe.

20. The Birds of Connecticut, by J. H. Sage and L. B. Bishop, assisted by W. P. Bliss.

21. Fifth Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1911-1912.

23. Central Connecticut in Geologic Time, by Joseph Barrell.

24. Triassic Life of the Connecticut Valley, by R. S. Lull.

25. Sixth Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1913-1914.

The publications made in cooperation with the United States Geological Survey are given on page 13.

Since the last Biennial Report, Bulletins 23 and 24 have been published. Bulletin 23, Central Connecticut in Geologic Time, by Joseph Barrell, deals with the series of geologic events affecting central Connecticut up to the present time. The conditions at successive epochs of geologic time are represented by structure sections.

Bulletin 24, Triassic Life of the Connecticut Valley, by Richard Swan Lull, deals with the fauna and flora of Triassic time in relation to its environment. It affords the most complete account of the many footprints — the so-called "bird tracks" — and of the few skeletons which constitute the evidence for the existence of dinosaurs in the Connecticut Valley.

BULLETINS IN PRESS OR APPROVED FOR PUBLICATION
BY THE BOARD OF CONTROL.

A bulletin on the Arthrostraca of Connecticut, by Beverly Waugh Kunkel, Professor of Biology in Lafayette College, is now in press. It treats in detail of two suborders of Crustacea which have been found in the State — Amphipods and Isopods — less fully of forms from neighboring States which possibly can be found in this State; and presents to the reader biologic, anatomic, and economic views of the subject.

A bulletin on the Hymenoptera of Connecticut (to appear as Bulletin 22), prepared under the direction of Wilton Everett Britton, by Henry Lorenz Viereck, and constituting Part III of a work on a Guide to the Insects of Connecticut, is also in press. Parts I and II of the Guide have appeared as Bulletin 16.

The Hymenoptera include many insects of interest to agriculturists.

The publication of a paper on the Peat Deposits of Connecticut, prepared by Charles Albert Davis, with the field assistance of E. C. Miller and T. T. Giffen, has been delayed on account of the recent death of the author. Because of his thorough knowledge of this subject, gained by a reconnaissance of the peat deposits of the coastal states from Maine to Florida, which he carried on under the United States Geological Survey, such a work by Mr. Davis will be of interest to the people of Connecticut from a scientific and economic standpoint.

BULLETINS ACCEPTED FOR PUBLICATION.

Four bulletins which have recently been completed by their authors have been accepted by the Superintendent for publication.

A Check-list of Insects of Connecticut, by Wilton Everett Britton, will be of value to institutions as well as to individuals in the identification of insects in the State. As Mr. Britton has been assisted in his work of records and identification of species by collectors and specialists in entomology in and near Connecticut, the list though necessarily incomplete is believed to be accurate. It has been preceded by Bulletins 16 and 22 (still in press) of this Survey, which also deal with the insects of the State, and is to be followed by another now in preparation dealing with Hemiptera.

A paper on the Quaternary Geology of the Southern Lowland of Connecticut has been prepared by Freeman Ward. It consists of descriptions of the preglacial, glacial, and postglacial conditions of the New Haven region and also of descriptions of the land formation, composition, and the causes thereof.

A paper has been prepared by Miss Ruth Sawyer Harvey on Drainage and Glaciation in the Central Housatonic Basin. The streams in this basin vary from the normal type and are discussed in relation to their geologic history. A general description of the region centering at Danbury is given from a geologic standpoint.

The Physical Geography and Geology of the Pawcatuck Valley has been prepared by Miss Laura Hatch. Its aim is to give a complete geologic and physiographic description of a region which contains type physiographic and petrographic features. A description of the area about Westerly, Rhode Island, is included.

The following bulletins accepted for publication have not yet been completed:

The Bacteria of the Fresh Waters of Connecticut, by H. W. Conn and L. R. (Potter) Hedenburg.

Report on Thames River Terraces, by F. P. Gulliver.
Decapods of Connecticut, by A. E. Verrill.
Hemiptera of Connecticut, by W. E. Britton and others.

COOPERATION WITH THE UNITED STATES GEOLOGICAL SURVEY.

During the years 1915-1916, the State Geological and Natural History Survey has cooperated with the United States Geological Survey in the study of the water resources of Connecticut. The contract under which cooperation was effected was that in force during the years 1911-1912 and 1913-1914 and renewed for the biennial term, 1915-1916.¹

Since by mutual consent the cooperative agreement ceases at the close of the Federal fiscal year, June 30, 1917, it is in order to review the results:

By the terms of the contract, the United States Geological Survey assumed responsibility for the prosecution of the work, and Herbert E. Gregory, Geologist of the Federal Survey, was appointed to direct the investigations. The purpose of the series of studies is to determine the position, amount, and quality of the waters—particularly underground waters—of the State of Connecticut and to discuss their economic utilization. The value of such studies depends upon their usefulness not only to communities using a common supply but to individual landholders, and the preparation of reports has, therefore, involved detailed mapping and local descriptions. The position of ground water with reference to the land surface has been determined, areas of open field, forest, rock, and types of glacial soil have been outlined; water from springs, wells, and brooks has been analyzed; and studies of the most economical and sanitary supplies for farms and villages have been made. By description and discussion in the text, by tabulation of statistics and representation of data on maps and sections, the conclusions of the authors regarding amount, quality, and availability of water supply of each town are given.

The field work has been carried on by members of the United States Geological Survey, Arthur J. Ellis, Gerald A. Waring, and Harold S. Palmer, whose names will appear as authors of the reports. The value of the investigations has been much increased by the supervision and assistance of O. E. Meinzer and R. B. Dole, officers of the Water Resources Branch of the Federal Survey.

¹The terms of the contract appear in the Sixth Biennial Report of the Commissioners of the State Geological and Natural History Survey, Bull. 25, pp. 8-10, 1915.

At the end of the present field season a survey of the following towns will have been completed:

Ansonia	Greenwich	Salisbury
Avon	Hartford	Saybrook
Barkhamsted	Hartland	Seymour
Beacon Falls	Harwinton	Simsbury
Berlin	Manchester	Southbury
Bethlehem	Marlborough	Southington
Bloomfield	Meriden	South Windsor
Bristol	Middlebury	Stamford
Burlington	Middlefield	Suffield
Canaan	Middletown	Thomaston
Canton	Naugatuck	Waterbury
Cheshire	New Britain	Watertown
Cromwell	New Canaan	Westbrook
Darien	New Hartford	West Hartford
East Granby	North Canaan	Weston
East Hartford	Norwalk	Westport
East Windsor	Old Lyme	Wethersfield
Enfield	Oxford	Wilton
Essex	Plainville	Windham
Farmington	Plymouth	Windsor
Franklin	Prospect	Windsor Locks
Glastonbury	Ridgefield	Wolcott
Granby	Rocky Hill	Woodbury

These 69 towns comprise 35 per cent of the area of the State and include 50 per cent of its population.

By agreement, the results of these investigations of the water resources of Connecticut are to be published as water-supply papers of the United States Geological Survey, and the expense of publication is to be met by the Federal Treasury. Each water-supply paper will bear the title: "Prepared in Cooperation with the Connecticut Geological and Natural History Survey," and the contract reserves the right of the State of Connecticut to publish or republish all or parts of the reports.

The following publications have appeared:

Ground Water in the Hartford, Stamford, Salisbury, Willimantic, and Saybrook Areas, Connecticut, by H. E. Gregory and A. J. Ellis, Water-Supply Paper 374, 1916.

Ground Water in the Waterbury Area, Connecticut, by A. J. Ellis, Water-Supply Paper 397, 1916.

Water-Supply Paper 374 represents the first systematic attempt to investigate the ground water in the State. The area described covers 715 square miles and includes the towns of Hartford, West Hartford, Newington, Wethersfield, East Hartford, Manchester, Windsor, East Windsor, South Windsor, Bloomfield, Stamford, Greenwich, Salisbury, Canaan, North Canaan, Windham, Franklin, Saybrook, Essex, Westbrook, and Old Lyme. The aim of the paper is to show how much water is stored under-

ground, how the supply fluctuates, what its quality is, how it can be procured, and how much can be secured from streams.

Water-Supply Paper 397 covers work on an area of about 171 square miles, and includes the towns of Ansonia, Seymour, Oxford, Beacon Falls, Naugatuck, Middlebury, Waterbury, Watertown, Thomaston. This region is rich in good water-power sites and well provided with water for municipal supplies, but the conflicting demands of water users have given rise to local problems of conservation. This report records facts and recommendations on which regulations for the use of water may be based.

These publications and also Water-Supply Paper 232, by H. E. Gregory, *Underground Water Resources of Connecticut*, which deals with the State as a whole, may be obtained free of charge from the Director, United States Geological Survey, Washington, D. C.

Papers in process of publication are the following:

Waters of the Pomperaug Valley, Connecticut, by A. J. Ellis. (Manuscript in preparation.) This report is based on field work done in 1913 and a series of stream, well, precipitation, and evaporation measurements carried on continuously from May, 1913, to December, 1916, by Ernest W. Parkin, George A. Parkin, and Ralph V. Woodcn, under the direction of A. J. Ellis and H. S. Palmer.

Ground Water in the Meriden Area, Connecticut, by Gerald A. Waring. (Manuscript completed.) This report covers the towns of Meriden, Berlin, Middlefield, Middletown, Cromwell, and Rocky Hill. It includes chapters on geography and geology of each town and discusses the water supplies in detail under the headings: water in till, water in stratified drift, water in bedrock, springs, wells, quality of water.

Water Resources of the Cheshire-Granby Area, Connecticut, by Harold S. Palmer. (Manuscript completed.) This report treats of the geography, surface geology, and water resources of the following towns: Cheshire, Prospect, Southington, Wolcott, New Britain, Plainville, Bristol, Plymouth, Farmington, Avon, Burlington, Harwinton, Simsbury, Canton, New Hartford, Granby, Barkhamsted, and Hartland.

Ground Waters of the Suffield, Glastonbury, and Norwalk Areas, Connecticut, by Harold S. Palmer. (Surveyed in 1916, manuscript in preparation.) The towns covered by this report are Suffield, East Granby, Windsor Locks, Enfield; Glastonbury, Marlborough; Norwalk, Darien, New Canaan, Westport, Weston, Wilton, and Ridgefield.

These reports are for general distribution and when published may be obtained free of charge by addressing: Director, United States Geological Survey, Washington, D. C.

The total expense to the State of Connecticut for the six years' investigation of water resources under the cooperative agreement is \$6,000. The Federal Government has expended an equal amount in addition to the cost of supervision and administration and the large expense of publication.

It is believed that this work, probably the most exhaustive study of a water-supply problem so far undertaken for a large area, has high value. The publications record basal studies whose results will become more useful as the population increases and problems of water rights and of sanitation become more complicated.

PLANS FOR FUTURE WORK.

I. Geology.

The geology and physical geography of Connecticut possess features of unusual interest. The bulletins already published, *The Manual of Geology*, *The Geological Map*, *Clays and Clay Industries*, *Triassic Life*, and other reports, have been found useful. It is desirable to continue geologic investigation to include other and more detailed studies of areas and special problems. Among the bulletins which should be prepared are the following:

Connecticut during the Ice Age. An explanatory description of the surface deposits, lakes, waterfalls, eskers, drumlins, and other topographic features for which the glaciers of Pleistocene time are responsible. Requests for the publication of such a report have come from teachers and other citizens.

Mineralogy of Connecticut. A descriptive list of the minerals of the State, their occurrence, their geologic relations, and economic value.

Physical Geography. A number of papers of moderate size dealing with the geographic factors concerned with the location of cities, of routes of travel, and the development of industries would find a useful place. The reports should be made of type localities and eventually combined to form a bulletin on the physical geography of the State.

Feldspars of Connecticut. A bulletin describing the location and extent of feldspar deposits and their availability for commercial purposes.

Road-making Materials. A study of rocks of the State with reference to their suitability for use as crushed stone for road construction and concrete.

II. Botany.

The systematic botany of the flowering plants of southern New England is comparatively well known and a list of flowering plants and ferns of Connecticut has been published by the Survey. Of the flowerless plants, the mosses, liverworts, fungi, fresh water algae and bacteria have been treated in Survey reports, which have received high commendation. Bulletins on the following subjects would be welcomed by students and investigators:

The Marine Algae of the Connecticut Shore.
The Lichens of Connecticut.

A series of bulletins on plant ecology, a study of the distribution and relations of plants with reference to soil, altitude, rainfall, etc., should be prepared. Such studies have been undertaken by surveys of other States and by various scientific organizations, and the published results are among the most interesting contributions to science.

III. Zoölogy.

Bulletins on the birds of Connecticut, on the fresh water Protozoa, on the Echinoderms and two parts of a Guide to the Insects of Connecticut have been published. A bulletin on the Amphipods and Isopods is in press, and Professor Verrill reports that his paper on the Crustacea is nearing completion. It is desirable that in future years bulletins should appear on mammals, fishes, reptiles, Amphibia, and on selected species of marine fauna. Their publication is desirable from both educational and economic viewpoints.

APPROPRIATION DESIRED.

In comparison with the financial support given by other states the appropriation for the Connecticut Survey is small. With \$1,500 a year, it is obviously impossible to pay salaries to a corps of scientific workers who devote their entire time to the State. Field work must be done in vacations by men who are willing to undertake such work for a nominal compensation. Laboratory investigation and writing of bulletins must be done either in vacations or at odd times by professors, teachers, and others who are interested in the educational scientific problems of the State. The amount of valuable material already published by the Survey in comparison with its very small cost is a striking illustration of the economy of this procedure.

It is the intention of the Superintendent to devote the appropriation which may be available for the years 1917-1919 to the

completion of investigations already commenced or contracted for and to the final preparation for publication of manuscripts which have been on hand for several years. For these purposes the amount which has been regularly appropriated for the past thirteen years will probably suffice if rigid economy be exercised. We shall, therefore, content ourselves with asking the General Assembly to renew the usual appropriation of \$3,000 for the ensuing biennial term. But it will be impossible to continue the work permanently on this basis. To offer a man of high scientific attainments \$50 or \$100 for an authoritative report on an investigation which may require his unoccupied time for two or three years is to demand a large public service with very little recognition. It is doubtful if the good will of such men as the Survey desires to employ can be treated as an asset for an indefinite length of time under conditions like this. If the work of the Survey is to be carried on in an efficient manner a biennial appropriation of at least \$5,000 will soon become essential.