Catalog of the First Duplicate Series of the Reigen Collection of Mazatlan Shells in the State Museum at Albany, New York

By

KATHERINE VAN WINKLE PALMER

Paleontological Research Institution, Ithaca, N. Y.

NEW YORK STATE MUSEUM
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CATALOG OF THE FIRST DUPLICATE SERIES OF THE REIGEN COLLECTION OF MAZATLAN SHELLS IN THE STATE MUSEUM AT ALBANY, NEW YORK[1]

By Katherine Van Winkle Palmer

INTRODUCTION

When the "S. S. Kangaroo" sailed from Liverpool on December 8, 1858, it had in its steerage, the Reverend Philip Pearsall Carpenter of Warrington, England, who had with him several large boxes of sea shells for the New York State Cabinet of Natural History, at Albany, N. Y. This "Kangaroo" may never have carried in its pouch a more unusual passenger or cargo, for Philip Carpenter was a minister who combined theology with very practical methods for the reform of crime and labor and the removal of pestilence and dirt. He was a vehement prohibitionist, abolitionist, and not the least, conchologist of reputation. The big boxes contained more than 6500 specimens of the "first duplicate" set of the famous Reigen Collection of Recent Mollusca from Mazatlan on the west coast of Mexico.

After a tempestuous voyage, from which neither Carpenter nor the shells suffered, came rough treatment of the specimens by the United States Custom House officials. A few of the shells were lost and some broken. Carpenter's indignation over the episode is still manifest by such labels (characteristically written on glass with white ink) as, "Broken by the U.S. Custom House officers." These fatalities, however, were of minor importance when compared with the total of uninjured shells which reached their final destination. The assemblage and its owner arrived in Albany on December 29th to be kindly received by Colonel Ezekiel Jewett, Curator of the State Cabinet of Natural History (Museum), and famous fossil and shell collector.

The material when finally assembled consisted of 6584 specimens, on 2285 glass tablets with representatives (either specimen, drawing or negative) of 421 species. It not only filled the cases available in "120 sq. ft. of space" but "60 ft." more were required to care for the total amount. Carpenter spent five weeks in Albany arranging the collection. After trips away from the New York State Cabinet quarters he returned to Albany in November 1859 and finished the job. He gave a lecture on his

[1] Manuscript submitted for publication June 1946.

shells with the Chancellor of the Board of Regents of The University of the State of New York in the chair. In recognition of his labors and his reputation in connection with the collection, after the presentation of the Mazatlan Collection to the State, Carpenter was given the degree of doctor of philosophy by the Regents. This was the first such degree to be given by that body.

During the intervals away from Albany, Carpenter had visited the leading conchologists and other scientists and institutions in America, had arranged the shell collections in the Smithsonian Institution, had given a series of lectures on Mollusca for that organization, and had travelled more than 12,400 miles in America. He had made contacts and established interests which ultimately led him to return to Montreal, Canada, to make his home. He died there in 1877, and his very large personal collection of Recent Mollusca was bequeathed to the Redpath Museum, McGill University, where it is still preserved intact.[1]

Philip P. Carpenter was responsible for the description of so many new species of living mollusks, particularly from the west coast of America, and his compilation of the literature and notes made on mollusks collections in Europe and America were so voluminous, that his influence is a primary factor in systematic work on that group of animal life. His name and labors are an important part of the history of American conchology. The New York State Cabinet of Natural History (State Museum) was thus the cradle of his American career.

The collection which Carpenter brought to Albany was a part of the immense assemblage gathered by a Belgian gentleman, Frederick Reigen, in 1848-50 at Mazatlan. The largest part of the material was sent in 1851 to Liverpool and Havre for sale. The Liverpool share which amounted to "about 14 tons of 40 cubic feet each," was purchased eventually by Carpenter and Herbert Thomas. The latter paid the greater cost and Carpenter did the work of identification and arrangement. The exact size of the collection may only be estimated, but Carpenter personally handled more than 100,000 specimens belonging to it. Carpenter states that, with the exception of the stores of Hugh Cuming, it was the largest collection of Mollusca ever brought to Europe from one locality. About 8873 specimens, which became the first or type set, were presented to the British Museum by Carpenter. He published a 552-page descriptive catalog in 1857, called Catalogue of the Collection of Mazatlan Shells in the British

[1] Palmer, K.V.W. Nautilus, v. 58, No. 3, 1945, p. 97-102.

Museum: collected by Frederick Reigen, described by Philip P. Carpenter. In this book 694 species (including 13 Bryozoa and one of Brachiopoda) were discussed, of which about 222 species were described as new. No illustrations accompanied the Mazatlan catalog, and only two of the new species were illustrated by the author. Carpenter, after segregating the type set for the British Museum, made up duplicate suites of the shells. The first duplicate series was offered through Dr Wesley Newcomb of Albany, world-known conchologist and collector, to the New York State Cabinet of Natural History on the same conditions as those presented to the British Museum: (1) that it be preserved separate and intact, (2) that it always be open to the use of students, (3) that the donor be allowed to arrange the collection, (4) and that a descriptive catalog be published. To satisfy the last conditions, the Regents of The University of the State of New York published a catalog (13th Ann. Rep't Regents, 1860) of the species presented to the State of New York.

At the "urgent insistence" of Doctor Newcomb the collection was accepted by the Regents for the State. The material came to the State as a gift from Carpenter and he was paid about $888 for his services in arranging it.

A glass plate with the specimens in the State Museum bearing Carpenter's label in white ink, reads:

Shell Fauna of Mazatlan

(95) (308)

The first duplicate series of the great Reigen Collection, (presented to the British Museum) was arranged, described, and given to the State of New York.

On conditions of being always preserved separate and intact in order to illustrate the *"British Museum Catalogue"* and the *"Report to the British Association,"* which accompany the Collection.

(N.B.)

The left hand numbers refer to the Species in the two works; those on the *right* to the tablet in the "Descriptive Catalogue" with which it most nearly coincides. The minute shells are not to be taken out of the test tubes.

P.P.C. Albany, Nov. 17th, 1859. E. Jewett, Curator.

Carpenter left with the collection in Albany a copy of the list of the Reigen Collection which was published in the Report of the 26th Meeting of the British Association for the Advancement of Science, 1857, pages 243-64. On this list he marked the specimens of which he had left representatives in Albany and noted the total number of specimens, tablets, species and test tubes. The compiled list of the New York State Collection included in the present report has been checked with that original list of Carpenter.

Additional duplicate sets of the Mazatlan material were prepared by Philip Carpenter and offered to the museums of St Petersburg, Berlin and Paris, on the same terms as those to the British Museum and the New York State Museum, but the collections were never accepted by those institutions. The sets were then offered to the Museum of Comparative Zoology at Harvard, McGill University and the Smithsonian Institution. Louis Agassiz made plans to accept such a suite for the Museum of Comparative Zoology but the gift was "declined after Agassiz's death by his successor, on the grounds of expense." The Harvard museum in more recent years acquired some Mazatlan specimens from the Boston Society of Natural History.

The Redpath Museum of McGill University has a Mazatlan collection of about 364 specimens, intact, arranged and labelled by Carpenter. There are several thousand unmounted shells.

The United States National Museum and the Chicago Natural History Museum have some Mazatlan material but in each case, as at the Museum of Comparative Zoology, the specimens are distributed systematically through the general collections.

As a result of circumstances, therefore, "the first duplicate" collection of Mazatlan shells, presented to the State of New York and now in the State Museum, remains the only collection, besides the original in the British Museum, comparable in size and which would warrant special consideration to the systematic revision and illustration of the fauna of the Mazatlan region. The American conchologists and paleontologists are primarily concerned with the understanding of Carpenter's work on Mazatlan. Only a small number of more than 200 new species described by Carpenter from Mazatlan have ever been figured. The type collection is in England and is thus not readily accessible to Americans. It is important then, and of practical value, that there is available on this side of the Atlantic a large and authentic Carpenter collection of the Mazatlan Catalogue, which until the type series in the British Museum is illustrated, may be used to help identify the forms.

The New York State Collection consists of more than 6500 specimens, of 421 species, on more than 2200 glass tablets and in 360 test tubes. The exact number may be determined by the included list. There are also 43 drawings and 24 negatives of photographs made by Carpenter of type or duplicate specimens which were deposited in the British Museum. Many of the negatives are too faint to show the detail of the shell characters. A larger set of such type drawings was left in the archives of the Smithsonian Institution by Carpenter and it was from that series that the Carpenter type figures of Mazatlan species were copied by Dall and Bartsch and published in 1909 in their monograph of the West Coast pyramidellid mollusks and by Bartsch in 1911, 1917 and 1920, in his papers on West Coast genera of mollusks. Thirty-five of the Carpenter drawings, mostly of species the types of which have not heretofore been figured, are included in this report.

The Albany Collection is still preserved (with some breakage and mixture) as Carpenter left it, except that the material is in storage. The specimens are mounted by the unique Carpenter method on glass tablets, the labels being written in white ink. The details of the technic are described by Carpenter in the footnote, page iii to the Preface of the Mazatlan Catalogue. The sketches and negatives are mounted in the same manner as the specimens. In a few cases, as mentioned, the glass tablets have been broken and mixed so that the tablet number of the specimens could not be determined. The species number, however, was obvious. A notation of such accidents has been made in the present catalog.

This account of the Mazatlan Collection in the New York State Museum was made while the author was employed as temporary expert in zoology during 1945-46 to inventory the extensive Recent molluscan collections of that Museum. The work in preparing this catalog consisted of an examination, count and record of each of the 2532 tablets of the 698 species as listed in the Mazatlan Catalogue by P. P. Carpenter and represented in the New York State Museum.

While Doctor Carpenter displayed exceptional patience and ingenuity in arranging and labeling his collections, he never numbered any of the specimens, trusting that the shells would always remain glued to the tablets. Because of their undisturbed condition through the years the authenticity of the labels has been maintained but unnumbered specimens are ever in a precarious state. Through the labor and patience of Marie Story, of East Greenbush, N. Y., the specimens of the New York State Mazatlan

Collection are now all numbered. Each specimen (where possible) bears a fractional number, the species number above and the tablet number below the line. Regardless of how the specimens may become disturbed hereafter, or if the collection is later arranged according to modern methods, each specimen can be tied into Carpenter's 1857 Mazatlan Catalogue and the present compiled list. The present list is arranged to be used with the Mazatlan Catalogue and interpreted by it. The list is also a supplement to the Catalogue of the New York State Collection, published by Carpenter in the 11th Ann. Rep't of the New York State Cabinet of Natural History (Museum).

The names given in the present catalog are those as proposed by Carpenter and no attempt has been made to revise the nomenclature or to bring it up to date. References to illustrations of figures of types published elsewhere have been included.

The author wishes to acknowledge the splendid cooperation and encouragement of Dr Carl E. Guthe, Director of the New York State Museum, under whose authority the inventory of the Mazatlan Collection of the New York State Museum and this report were made. Thanks are due to Alvin G. Whitney, Assistant Director of the New York State Museum, and to Mary B. Brewster, reference librarian, New York State Library. The writer is grateful to J. C. Vickery of the British Museum (Natural History); Dr Paul Bartsch, United State National Museum; Alice Johannsen Turnham, Redpath Museum, McGill University; R. Tucker Abbott, United States National Museum, formerly of Museum of Comparative Zoology, Harvard University; Dr Fritz Haas, Chicago Natural History Museum, for information supplied concerning the Mazatlan material in their respective institutions; and to Marie Story of East Greenbush, N. Y.

CATALOG

1 **Membranipora denticulata** Busk (n.s.)

Tablet 1, sp.[1] on *Uvanilla olivacea.*—1 b, sp. on *Anomia lampe.*—? 1 b, sp. on *Anomia lampe.*—1, 4 b, sp. on *Uvanilla olivacea* with 1 and 3.

2 **Membranipora gothica** Rylands ms. (n.s.)

Tablet 2, 2 sp. on *Uvanilla unguis.*

3 **Lepralia atrofusca** Rylands ms. (n.s.)

Tablet 4 b, sp. on *Anomia lampe* and another on 1, 4 b on *Uvanilla olivacea* with 1 and 6.

4 ———

5 ———

6 **Lepralia rostrata** Busk (n.s.)

Tablets 8, 12 (together), sp. on *Pisania gemmata.* Also with 1 and 3 on Tablets 1, 4 b, on *Uvanilla olivacea.*

7 ———

8 ———

9 **Lepralia humilis** Busk (n.s.)

Tablets 8, 12 (together) sp. on *Pisania gemmata.*

10 **Lepralia appressa** Busk

Tablet 13, 2 sp. on *"Leucozonia cingulatus, Pisania insignis, Columbella major,* and *C. fuscata."*

11 ———

12 **Cellepora cyclostoma** Busk (n.s.)

Tablet 15, sp. on *Uvanilla unguis.*—[? 12] 15 b sp. on *Anomia lampe.*—16.—.

13 **Defrancia intricata** Busk (n.s.)

Tablet 17, sp. on *Uvanilla unguis.*—17 b, sp. on *Avicula sterna.*

14 **Discina Cumingii** Broderip

Tablet 19, sp. gone.

15 **Pholadidea melanura** Sowerby

Tablet 21, sp. of both valves.

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[1] sp = abbreviation for specimen when used in regard to the number of specimens; when used with generic name refers to species.

16 **Pholadidea ? curta**

Tablet 22, 1 sp. present (1 sp. gone).

17 **Parapholas calva** Gray ms.

Tablet 23, vial containing 2 sp.—24, 2 sp. of both valves.—25, burrow in *Spondylus calcifer.*—26, —. 27, 3 sp. (1 large, both valves together; 1 medium, both valves separated).—28, 1 sp. and burrow in *Spondylus calcifer.*—29, 1 double sp. and 3 fragments.—30, burrow in *Spondylus calcifer* with 3 young sp.—31, burrows.—32. —. 33, 10 fragments of gray deposit. —34, 6 fragments. —35, 19 fragments of laminae. —36, 14 fragments of umbonal plate. —37, 7 fragments of the dorsal and ventral plates.

18 **Parapholas acuminata** Sowerby

Tablet 38, 1 large double sp., valves together. —39, 1 complete medium size sp. —40, 1 double sp.

19 **Martesia intercalata,** n.s.

Tablet 41, negative of photo of 5 sp., syntypes, B.M. sp.

20 Tablet 42,————.

21 **Gastrochaena truncata** Sowerby

Tablet 43, 8 young sp. in vial. —44, sp. on *Uvanilla unguis.* —45, sp. on *Purpura triserialis.* —45, sp. and 176 (596) on *Uvanilla olivacea.* 46, sp. on *Uvanilla olivacea.* —47, sp. on *U. olivacea.* —48, sp. on *U. olivacea.* —49, 2 young sp. in 2 fragments of *Spondylus calcifer.* —50, 3 large sp., 1 small and 1 fragment, 1 large sp. displays a pearl in the middle of the shell. —51, sp. on 4 fragments. —52, —. 53, —. 54, pipe end in fragment of *Spondylus calcifer.* —54, (duplicate), 2 fragments of pipe ends. —54 b, 1 pipe end. —55, sp. on *S. calcifer.*

22 **Gastrochaena ovata** Sowerby

Tablet 56, 3 young sp., fragment, and burrow. —57, sp. gone. —58, 3 valves (2 gone). —59, burrows in fragment of *S. calcifer.*

23 **Savicava arctica** Linnaeus

Tablet 60, vial with 10 valves. —61, 1 double sp. and 3 fragments (1 gone). —62, —. 63, sp. in burrow of *Lithodomus* in *Spondylus calcifer.* —64, —.

24 **Petricola robusta** Sowerby
Tablet 65, 1 double sp. and fragments of burrows. —66, 2 double sp. and 2 separate valves. —67, 1 perfect double sp. —68, 1 double sp. and 2 fragments. 68*, see p. 547 B.M. Cat., two small fragments and a large fragment in *Spondylus calcifer*. 69. —.

25 **Petricola ventricosa** Deshayes
Tablet 70, contains 2 opposite valves.

26 **Petricola** ————, sp. ind.
Tablet 71, vial with 1 fragment.

27 **Rupellaria lingua-felis,** n.s.
Tablet 72, vial with 7 sp.

28 **Rupellaria exarata,** n.s.
Tablet 73, vial with 6 sp. and sp. *in situ* in *Balanus*.

29 **Rupellaria** ————, sp. ind.
Tablet 74—.

30 **Corbula bicarinata** Sowerby
Tablet 75, 1 double sp.

31 **Corbula biradiata** Sowerby
Tablet 76, —.

32 **Corbula pustulosa,** n.s.
Tablet 77, vial with 1 valve drilled.

33 **Corbula ? ovulata** Sowerby
Tablet 78, —.

34 **Corbula** ————, sp. ind.
Tablet 79, vial containing a fragment.

35 **Sphaenia fragilis,** n.s.
Tablet 80, vial containing 7 sp. —80, (duplicate) contains 9 sp. —81, vial containing 6 valves. —82, vial with 21 fragments.
Tablet 83, —.

36 **Lyonsia picta** Sowerby
Tablet 84, vial containing 2 fragments. —85, —.

37 **Solecurtus affinis** C. B. Adams
Tablet 86, 4 double and 2 single sp. —87, 3 double adults. —88, 3 double adults. —89, 3 double adults.

38 **Solecurtus politus,** n.s.
Tablet 90, 1 perfect double sp.

39 ? **Solecurtus** ————, sp. ind.
Tablet 91, —.

40 **Semele flavescens** Gould [*non Semele proxima* C. B. Adams]
See p. 548 B.M. Cat.
Tablet 92, 1 single valve. —93, 3 large double sp. —94, 3 large doubles. —95, 3 large doubles. —96, 2 large doubles. —97, 3 large medium size doubles. —98, 1 double. 99, 1 double.

41 **Semele ? venusta** A. Adams
Tablet ? 100, 1 valve.

42 **Cumingia lamellosa** Sowerby
Tablet 101, vial containing 2 sp. and fragment. —102, 1 imperfect sp. —103, sp. in 2 fragments of *Spondylus calcifer.*

43 **Cumingia trigonularis** Sowerby
Tablet 104, 2 doubles and vial containing 1 double and 2 fragments.

44 **Cumingia Californica** Conrad
Tablet 105, 1 perfect double sp.

45 **Cumingia** ————, sp. ind.
Tablet 106, vial containing 1 double and 1 larger single valve.

45b ————
Tablet 107, vial with 1 double sp.

46 **Sanquinolaria miniata** Gould = *S. purpurea* Deshayes
[See App., B.M. Cat., p. 548.]
Tablet 108, 1 all pink or rosy double.

47 **Tellina rufescens** Chemnitz
Tablet 109, 1 large double.

48 **Tellina Broderipii** Deshayes ms. (*Teste Cum.*)
Tablet 110, —.

49 **Tellina ?? Mazatlanica** Deshayes
Tablet 111, —.

50 **Tellina Dombei** Hanley
Tablet 112, —.

51 **Tellina felix** Hanley
Tablet 113, vial containing 2 fragments.

52 **Tellina straminea** Deshayes
Tablet 114, —. 115, vial containing 1 fragment.

53 **Tellina donacilla,** n.s.
Tablet 116, vial containing note "broken by U.S.C.H. officers."

54 **Tellina punicea** Born
Tablet 117, 2 beautiful rosy perfect doubles.

55 **Tellina ? Cumingii** Hanley
Tablet 118, —.

56 **Tellina ? eburnea** Hanley = *Cycladella papyracea* Carpenter, 1863.
Tablet 119, vial containing fragment.

57 **Tellina regularis,** n.s.
Tablet 120, —.

58 **Tellina lamellata,** n.s.
Tablet 121, vial containing 5 fragments.

59 **Tellina ?? puella** C. B. Adams
Tablet 122, —.

60 **Tellina ?? delicatula** Deshayes
Tablet 123, —.

61 **Tellina brevirostris** Deshayes
Tablet 124, —.

62 **Tellina ? denticulata** Deshayes
Tablet 125, vial containing 1 tiny double.

63 **Tellina** ————, sp. ind.
Tablet 126, —.

64 **Tellina** ————, sp. ind.
Tablet 127, vial containing a fragment.

65 **Tellina Burneti** Broderip and Sowerby
Tablet 128, 11 valves.

66 **Strigilla (Tellina) carnaria** Linnaeus
Tablet 129, 3 doubles and 3 single valves with some shells broken since Carpenter's deposit. 129*, vial with double sp.

67 ? **Strigilla lenticula** Philippi
Tablet 130, vial with fragment.

68 ————, sp. ind.
Tablet 131, —.

69 **Iphigenia altior** Sowerby
Tablet 132, 5 doubles. —133, 5 doubles. —134, 3 large excellent sp. —135, sp. with fracture mended by the animal. —136, 1 perfect double.

70 **Iphigenia ? laevigata** ? *"cujus."*
Tablet 137, —.

71 **Donax carinatus** Hanley
Tablet 138, 1 double and 1 single sp.

72 **Donax rostratus** C. B. Adams instead of *D. culminatus*
See p. 548, B.M. Cat.
Tablet 139, 1 double.

73 **Donax transversus** Sowerby
Tablet 140, —.

74 **Donax assimilis** Hanley
Tablet 141, —.

75 **Donax punctato-striatus** Hanley
Tablet 142, 6 doubles. —143, 6 doubles. —144, 5 doubles. 145, 5 doubles. —146, 6 doubles. —147, 5 doubles. —148, 5 doubles. —149, 6 doubles. —150, 5 doubles (1 valve gone). —151, 1 double and 1 single. —152, 5 doubles. —153, 5 doubles. —154, 5 doubles. —155, 6 doubles. —156, 4 doubles (and 1 single gone). —157, 1 double and 1 single. —158, 6 doubles. —159, 5 doubles. —160, 3 doubles (and 1 single gone). —161, 1 double. —162, 1 double. —163, 2 doubles. 164, 1 double. —165, 1 double. —166, 1 double —167, 1 double.

75b **Donax** ? **punctatostriatus** var. **caelatus**
Tablet 168, 3 doubles.

76 **Donax Conradi** Deshayes
Tablet 169, —. 170, 1 double and 1 single. —171, —. 172, 2 doubles. —173, 1 double.
Tablet 174, 3 doubles. —175, 7 doubles. —176, 8 doubles and 1 single. —177, 6 doubles. —178, 4 doubles. —179, 5

doubles. —180, 3 doubles. —181, 7 doubles. —182, 4 doubles. —183, 5 doubles. —184, 7 doubles. —184*, (duplicate) vial containing 3 doubles. —185, 7 doubles. —186, 9 doubles. —187, 5 doubles. —188, 2 doubles and 1 single. 189, 3 doubles. —190, 5 doubles. —191, 5 doubles. —192, 5 doubles. —193, 7 doubles. —194, 6 doubles. —195, 4 doubles. —196, 10 doubles. —197, 10 doubles. —198, 7 doubles. —199, 3 doubles. —200, 2 doubles —201, 1 double.

77 **Donax navicula** Hanley
Tablet 202, 4 doubles. —203, 3 doubles. —204, 3 doubles. —205, 3 doubles. —206, 3 doubles. —207, 1 double. —208, vial containing 5 doubles and 2 broken valves. —209, 2 doubles. —210, —.

78 **Mactra exoleta** Gray
Tablet 211, —. 212, 2 doubles.

79 **Mactra (Spisula) fragilis** Chemnitz
Tablet 213, —.

80 **Mactra (Mulinia) angulata** Gray ms.
Tablet 214, 1 double.

81 **Gnathodon mendicus** Gould [*Non G. trigona* Petit]
Carpenter, B.M. Cat., App., p. 549.
Tablet 215, 4 doubles.

82 ? **Clementia gracillima**, n.s.
Tablet 216, —.

83 **Trigona radiata** Sowerby
Tablet 217, 2 doubles. —218, 1 double. —219, 1 double. —220, 2 doubles. —221, 1 double. —222, 1 double. —223, 1 double. —224, 1 double. —225, 4 doubles. —226, 2 doubles. —227, 1 double. —228, —. 229, 2 doubles. —230, 1 double. —231, 1 double. —232, 1 double. —233, 2 doubles. —234, 1 double. —235, 1 double. —236, 2 doubles. —237, 1 double. —238, 1 double. —239, 2 doubles. —240, 1 double. —241, 1 double. —242, vial containing 3 young sp. —243, vial containing 2 sp.

84 **Trigona humilis**, n.s.
Tablet 244, 7 double specimens in vial.

85 **Trigona argentina** Sowerby
Tablet 245, —. 246, 1 double.

86 **Trigona ?? crassatelloides** Conrad

Tablet 247, vial containing 1 valve.

87 **Trigona planulata** Broderip and Sowerby

Tablet 248, 3 doubles. —249, 1 double. —250, 1 double. —251, 2 doubles. —252, 1 double. —253, 1 double. —254, 1 double. —255, 1 double. —256, 2 doubles.

88 **Dosinia ? ponderosa** Gray

Tablet 257, vial containing 1 young specimen.

89 **Dosinia Annae,** n.s.

Tablet 258, 1 double.

90 **Dosinia Dunkeri** Philippi

Tablet 259, 3 doubles. —260, 4 doubles. —261, 4 doubles. —262, 3 doubles. —263, 4 doubles. —264, 4 doubles. —265, 3 doubles.

91 **Cyclina subquadrata** Hanley

Tablet 266, 1 double.

92 **Dione aurantia** Hanley

Tablet 267, vial containing 3 young. —268, 2 doubles. —269, 2 very large doubles. —270, 1 distorted double. —271, 1 large double.

93 **Dione chionaea** Menke

Tablet 272, vial containing 9 sp. —273, 5 doubles, different sizes. —274, 1 double. —275, 2 doubles. —276, 1 double. —277, 2 doubles. —277 (duplicate), 4 doubles different sizes. —278, 3 doubles, different sizes. —279, —. 280, —. 281, 1 double. —282, 5 doubles. —283, 2 doubles.

94 **Dione rosea** Broderip and Sowerby

Tablet 284, vial containing 1 very young valve. —285, 4 doubles. —286, 3 doubles. —287, 1 double. —288, 2 doubles (1 gone). —289, 1 double. —290, 1 double. —291, 1 double. —292, 1 double. —293, 1 double.

95 **Dione lupinaria** Lesson

Tablet 294, —. 295, 10 small doubles. —296, 7 doubles. 297, 2 doubles. —298, 2 large and medium doubles. —299, 8 small doubles. —300, 8 doubles. —301, 5 doubles. —302, 2 doubles. —303, 5 doubles. —304, 3 doubles. —305, 2 doubles. —306, 1 double. —307, 3 doubles. —308, 2 doubles.

—309, 1 double "Broken by U. S. Custom House officers." —310, 1 double. —311, 1 double. —312, 1 double.

96 **Dione ? vulnerata** Broderip
Tablet 313, —.

97 **Dione ? brevispinosa** Sowerby
Tablet 314, —.

98 **Dione circinata** Born
Tablet 315, —.

99 **Dione concinna** Sowerby
Tablet 316, —.

100 **Cytherea petechialis** Lamarck
Tablet 317, vial containing 2 young sp. —318, 1 sp.

101 **Venus (Chione) gnidia** Broderip and Sowerby
Tablet 319, vial containing 3 young. —320, 4 doubles. —321, 2 doubles. —322, 2 doubles. —323, 2 doubles. —324, 2 doubles. —325, 2 large doubles. —326, 4 doubles. —327, 2 large doubles. —328, 2 doubles. —329, 2 doubles. —330, 3 large doubles. —331, 5 doubles. —332, 4 doubles. —333, 3 large doubles. —334, 1 double. 335, —. 336, 1 double. —337, 1 double. —338, 1 double. —339, 2 doubles. —340, 2 doubles.

102 **Venus (Chione) amathusia** Philippi
Tablet 341, 1 double adult [? 102 ? 341, vial containing 1 young]. —342, 4 doubles. —343, 1 double. —344, 1 double. —345, 2 doubles. —346, 1 double. —347, 1 double. —348, 1 double. —349, 2 doubles.

103 **Venue (? Chione) ———**, sp. ind.
Tablet 350, vial containing 2 doubles. —351, vial containing 2 doubles and a fragment. —353, vial containing 3 valves.

104 **Venus (? Chione) distans** Philippi
Tablet 353, —.

105 **Venus (Chione) crenifera** Sowerby
Tablet ? 354, vial containing 2 fragments. 355, 1 double.

106 **Venus (Chione) ? undatella** Sowerby
Tablet 356, —.

107 **Venus (Chione) Columbiensis** Sowerby

Tablet 357, vial containing 2 young doubles and 2 fragments. —358, 5 sp. —359, 5 sp. —360, 5 sp. —361, 5 sp. —362, 5 doubles (1 gone).

108 **Venus (? Chione)** ———, sp. ind.

Tablet 363. —.

109 **Tapes histrionica** Broderip and Sowerby

Tablet 364, 5 doubles. —365, 5 sp. —366, 5 sp. —367, 5 doubles. —368, 5 doubles. —369, 7 doubles.

110 **Tapes grata** Say

Tablet 370—371, 1 double.

[Carpenter's ms. check has blank for this number but that is apparently a slip on Carpenter's part as the tablet and numbers are authentic.]

111 **Tapes squamosa,** n.s.

Tablet 372, —.

112 **Anomalocardia subrugosa** Sowerby

Tablet 373, —. 374, 3 doubles. —375, 5 doubles. —376, 3 doubles. —377, 3 doubles. —378, 3 doubles. —379, 3 doubles. —380, 3 doubles. —381, 2 doubles. —382, 5 doubles. —383, 3 doubles. —384, 3 doubles. —385, 3 doubles. —386, 3 doubles. —387, 5 doubles. —388, 2 doubles. —389, 2 doubles. —390, 1 double. —391, 1 double. —392, 2 doubles. —393, 1 double. —394, 1 double. —395, 1 double. —396, 2 doubles. —397, 3 doubles. —398, 2 doubles. —399, 2 doubles. —400, 2 doubles. —401, 1 double. —402, 1 double. —403, 2 doubles. —404, 2 doubles. —405, 1 double. —406, 2 doubles. —407, 3 doubles. —408, 3 doubles.

113 **Anomalocardia subumbricata** Sowerby

Tablet 409, vial containing 3 sp. —410, 1 double. —411, —.

114 **Circe margarita,** n.s.

Tablet 412, vial containing open pair.

115 **? Circe subtrigona,** n.s.

Tablet 413, vial containing 10 sp.

116 **Gouldia Pacifica** C. B. Adams

Tablet 414, vial containing 3 fragments.

117 **Gouldia varians**, n.s.

Tablet 415, 12 pair and 2 fragments. —416, 4 pair (smallest with one valve broken). —417, vial containing 2 pair and a single valve. —418, vial containing 3 sp. —419, 3 pair and 4 single sp.

118 **Cardita Californica** Deshayes

Tablet 420, vial with 4 doubles and 1 single. —421, —. 422, 1 adult double.

119 ? **Venericardia** ———, sp. ind.

Tablet 423, —.

120 ? **Trapezium** ———, sp. ind.

Tablet 424, —.

121 **Chama frondosa** Broderip var. **Mexicana**

Tablet 425, vial containing 2 young. 426-431, —. 433, pair, orange "outside with Vermetidæ"—434, —. 435, 1 double "diseased sp., purple attached by Lithophagi, even to the very centre of the teeth."—436, 1 large double and vial containing 2 young. 437-438, —.

121b **Chama** ? **frondosa**: var. **fornicata**

Tablet 439, vial containing 4 fragments. —440, 1 pair. —441, 1 pair; 1 pair on a rock. —442, —. 443, 1 large double.

122 **Chama spinosa** Broderip

Tablet 444, 1 sp.

123 **Chama** ? **exogyra** Conrad

Tablet 445, —.

124 **Cardium (Laevicardium) elatum** Sowerby

Tablet 446a, 1 double. —446b, 1 large double. —477, vial containing 1 sp.

125 **Cardium procerum** Sowerby

Tablet 448, vial containing fragment. —449, 3 doubles. —450, 3 doubles. —451, 4 doubles. —452, 2 doubles. —453, —.

126 **Cardium** ? **senticosum** Sowerby

Tablet 454, vial containing fragments.

127 **Cardium** ———, sp. ind. (*a*)

Tablet 455, vial containing fragment.

128 **Cardium** ———, sp. ind. (*b*)
Tablet 456, negative of photo of B.M. sp. —? 456, a fragment in vial.

129 **Cardium** ———, sp. ind. (*c*)
Tablet 457, —.

130 **Cardium** ———, sp. ind. (*d*)
Tablet 458, —.

131 **Cardium** ———, sp. ind. (*e*)
Tablet ? 459, — vial containing fragment.

??132 **Cardium** ———, sp. ind. (*f*)
Tablet ?? 460, vial containing a fragment.

133 **Cardium alabastrum,** n.s.
Tablet 461, vial containing 1 sp.

134 **Cardium graniferum** Broderip and Sowerby
Tablet 462, vial containing 2 fragments.

135 ? **Cardium** ———, sp. ind. (*g*)
Tablet 463, —.

136 **Lucina (Codakia) tigerina** Linnaeus
Tablet 464, —.

137 **Lucina ?? punctata** Linnaeus
Tablet 465, —.

138 **Lucina ? annulata** Reeve
Tablet 466, —.

139 **Lucina ? muricata** Chemnitz
Tablet 467, —.

140 **Lucina excavata,** n.s.
Tablet 468, vial containing 1 fragment.

141 **Lucina** ———, sp. ind.
Tablet 469, —.

142 **Lucina pectinata,** n.s.
Tablet 470, negative of photo of type, B.M. sp. (left valve), and a vial containing a fragment.

143 **Lucina cancellaris** Philippi
Tablet 471, vial containing 1 double.

144 **Lucina Mazatlanica,** n.s.
Tablet 472, vial containing 5 doubles (1 valve of the smallest gone). 473, —.

145 **Lucina prolongata,** n.s.
Tablet 474, vial containing 1 double and 3 singles, large and small.

146 ? **Lucina** ————, sp. ind.
Tablet 475, —.

147 **Lucina ? eburnea** Reeve
Tablet 476, "Lost by U.S.C.H. officers."

148 **Lucina** ————, sp. ind.
Tablet 477, vial containing 2 fragments.

149 ? **Fimbria** ————, *jun.* sp. ind.
Tablet 478, vial containing 2 singles.

150 **Diplodonta semiaspera** ? Philippi
Tablet 479, vial with medium sp. —. 480, 1 double.

150b **Diplodonta ? semiaspera** var. **discrepans**
Tablet 481, —.

151 **Diplodonta obliqua** Philippi
Tablet 482, —.

152 ? **Diplodonta serricata** Reeve
Tablet 483. —. 484, 5 doubles and 2 single valves.

153 **Kellia suborbicularis** Montagu
Tablet 485, vial containing a large and small pair. —485 (dup.), vial containing 3 pair. —486, vial containing label "Lost by U.S.C.H. officers." —487, vial containing 7 doubles and 2 single valves. —488, —. 489, [glass mount, vial not found]. —490, vial with 2 doubles mounted singly. —491, vial with 2 single valves. —492, vial with 4 doubles. —493, vial with 5 sp. —494, —.

154 **Lasea ? rubra** Montagu
Tablet 495, —.

155 **Lasea trigonalis,** n.s.
Tablet 496, —.

156 ? **Lasea oblonga,** n.s.
Tablet ?? 497, vial containing 1 minute broken valve.

157 **Lepton Clementinum**, n.s.
Tablet 498, —.

158 **Lepton Dionaeum**, n.s.
Tablet 499, —.

159 **Lepton umbonatum**, n.s.*
Tablet 500, vial containing 1 tiny sp. of 2 valves.

160 **Pythina sublaevis**, n.s.
Tablet 501, vial containing 1 sp.

161 **Montacuta elliptica**, n.s.
Tablet 502, vial containing 1 sp.

162 ? **Montacuta subquadrata**, n.s.
Tablet 503, vial containing 1 sp.

162 **Montacuta** ————, sp. ind.
[No. 162 duplicated.]
Tablet 504, —.

163 ————

164 **Cyrena olivacea**, n.s.
Tablet 505, 1 double.—506, 1 double.—507, 2 doubles.—508, 1 double.—509, 1 double.—510, 1 double.—511, 1 double.

165 **Cyrena Mexicana** Broderip and Sowerby
Tablet 512, 4 doubles.—513, 3 doubles.—514, 3 doubles. 515, 3 doubles.—516, 3 doubles.—517, 3 doubles.—518, 5 doubles.—519, 2 doubles (1 gone).—520, 4 doubles.—521, 1 double.—522, 4 doubles.

166 **Anodonta ciconia** Gould
Tablet 523, 3 doubles.—524, 2 doubles.—525, 2 doubles.—526, 1 double.—527, 2 doubles.

167 **Mytilus palliopunctatus** Dunker
Tablet 528, vial, 3 doubles and 1 medium sp.—529, 1 double.—530, 8 doubles.—531, 5 doubles.—532, 5 doubles.—533, 4 doubles.—534, 1 double.—535, —. 536, 3 doubles.—537, 1 double.—538, 3 doubles.—539, 3 doubles.

168 **Mytilus multiformis**, n.s.
Tablet 540, — vial containing 3 doubles and 3 singles.—540*, vial containing 5 doubles. —541, vial containing 10

doubles and 3 doubles gone.—542, 5 doubles and 1 single. —543, vial containing 5 pairs and 5 doubles.—544, 1 single and vial containing 6 valves.—545, vial, 4 doubles (2 *in situ*). —546, —. 547, —. 548, 3 doubles, 2 singles and a fragment. —549, vial containing 3 doubles and 2 singles. —550, vial containing 2 doubles and a single.—551, vial containing 5 fragments.—552, vial with 10 doubles and 1 single.

169 **Septifer Cumingii** Récluz
Tablet 553, vial containing 1 double.

170 **Modiola capax** Conrad
Tablet 554, 5 doubles.—555, 2 doubles.—556, 1 large double with small box of epidermis fragments.—557, —.

171 **Modiola Brasiliensis** Chemnitz
Tablet 558, 1 large double.

171b **Modiola ? Brasiliensis var. mutabilis**
Tablet 559, 1 double.—560, 2 doubles.—561, 1 double.—562, 1 double.—563, 1 double.—564, 1 large specimen, distorted.—565, —.

172 **Crenella coarctata** Dunker
Tablet 566-7, vial with 1 double, duplicate vial with 2 doubles. —567, vial with double and 1 larger single. —567*, vial with a fragment.

173 **Lithophagus attenuatus** Deshayes
Tablet 568 etc. 4 doubles in fragments of *Uvanilla* and *Spondylus*. (Some broken.) —569, —. 570, —.

174 **Lithophagus calcyculatus**, n.s.
Tablet 571, 3 fragments (2 gone).

175 **Lithophagus plumula** Hanley
Tablet 572, vial containing 6 sp.—573, 3 doubles (1 broken.) —574, in 3 sp. *Uvanilla unguis*.—574 (dup.), double in fragment of *Spondylus*.—575, in fragment of *Spondylus*.—576, 14 fragments.—577, 8 fragments.—578, 2 doubles, large and small.—579, 7 fragments.—580, —.

176 **Lithophagus aristatus** Solander
Tablet 581,—582; 581, vial with 1 double and 8 singles. —581*, vial with 7 doubles and 1 single.—582, vial with 5 doubles.—582, vial with 4 doubles and a byssus.—583, —.

584, 9 sp.—585, 5 doubles (valve of 1 gone).—586, 3 fragments.—587, 1 double.—588, 1 sp. in *Spondylus* fragment.—589, 1 double in *Spondylus*.—590, —. 591, 3 sp.—592, 1 sp. on *Fissurella alba*.—593, 2 fragments.—594, —. 595, in sp. of *Uvanilla olivacea* with bore across the apex.—596,—with 21 (45).—597, 2 sp. and 2 bored shells of *Uvanilla olivacea*.—598, 4 fragments, pipe ends.—599, 20 sp. of posterior extremities.—600, 14+ fragments (some broken).

Lithophagus aristatus var. **gracilior**
Tablet 601, 5 sp.

Lithophagus aristatus var. **tumidior**
Tablet 602, small double. 603.— 1 double.

177 **Lithophagus cinnamomeus** Chemnitz
Tablet 604, 2 sp.

178 **Leiosolenus spatiosus**, n.s.
Tablet 605, 1 sp. (broken).—606, attached valve of *Spondylus calcifer* with several burrows of "*L. spatiosus* enclosing *Cumingia lamellosa*, etc. Presented by R. D. Darbishire, Esq."; Plaster cast of burrow of *Gastrochaena truncata*.

179 **Leiosolenus** ————, sp. ind.
Tablet 607, —.

180 **Arca grandis** Broderip and Sowerby
Tablet 608, —. 609, —. 610, 1 very large double. 611, —. 612, —. 613, —. 614, 4 doubles. —615, —. 616, —. 617, 3 young doubles.—618, 1 double.—619, —. 620, 3 doubles.—621, 1 large double.—622, —. 623, 1 large double.—624, 1 large diseased double.—625, —. 626, 1 large double.—627, 1 large specimen, hinge fractured and mended by the animal. [Several specimens in addition, the glass tablets of which had been broken before 1945 so that the tablet number could not be determined.]

181 **Arca multicostata** Sowerby
Tablet 628, —. 629, —.

182 **Arca ? labiata** Sowerby
Tablet 630, —.

183 **Arca bifrons**, n.s.
Tablet 631, —.

184 **Arca tuberculosa** Sowerby
Tablet 632, 2 sp.—? 632, vial with 1 specimen. 633, —. 634, [several but glass has been broken, can not determine just what belonged with number]. 635, same as 634. 635b, 1 double. 636, 3 doubles. 637, 4 doubles.

185 **Arca reversa** Gray
Tablet 638, —.

186 **Arca ? brevifrons** Sowerby
Tablet 639, 2 negatives of photo of both valves, B.M. sp,

187 **Arca emarginata** Sowerby
Tablet 640, 1 sp.

188 **Arca** ————, *jun.* sp. ind.
Tablet 642*, vial containing young sp.

?188 Tablet ? 642, vial containing 2 valves.

189 **Byssoarca Pacifica** Sowerby
Tablet 643, vial containing 1 valve. 644, 1 sp. 645, 2 large doubles. 646, 1 large double. 647, 1 large double.

190 **Byssoarca mutabilis** Sowerby
Tablet 649, vial containing 1 sp.; duplicate with 3 doubles.

191 **Byssoarca fusca** Bruguière
Tablet 650, —.

192 **Byssoarca vespertilio,** n.s.
Tablet 651, —.

193 **Byssoarca illota** Sowerby
Tablet 652, 1 double.

194 **Byssoarca gradata** Broderip and Sowerby
Tablet 653, vial containing 7 doubles. 655, vial containing 6 doubles, mounted with 653 with 2 doubles. Duplicate 655, with 5 doubles. 654, —. 656, vial with 5 single valves.

195 **Byssoarca solida** Sowerby
Tablet 657, vial with single sp.—658, 3 doubles.—659, 3 doubles.—660, 3 doubles.—661, 3 doubles.—662, 3 doubles.—663, 2 sp. with negative of photo of 3 doubles, B. M. sp. "showing the interior."

196 **Pectunculus inaequalis** Sowerby
Tablet 664, —. 665, —.

197 **Pectunculus ? multicostatus** Sowerby
Tablet 666, —.

198 **Nucula ? exiqua** Sowerby
Tablet 667, —.

199 **Leda ? Elenensis** Sowerby
Tablet 668, vial containing 1 sp.

200 **Pinna maura** Sowerby
Tablet 669, —.

201 **Pinna lanceolata** Sowerby
Tablet 670, 4 sp. [some broken]. —671, sp. gone. 672, —. 673, sp. broken. —674, specimens broken.

202 **Pinna ? rugosa** Sowerby
Tablet 675, sp. broken.

203 **Avicula sterna** Gmelin
Tablet 676, —. 677, 6 doubles and 2 single valves. 678, 4 doubles.—679, 3 doubles mounted to show interior.—680, 4 doubles.

204 **Margaritiphora fimbriata** Dunker [*Non M. Mazatlanica* Hanley, changed by Carpenter, B. M. Cat., App., p. 550.] Tablet 681, —. 682, —.

205 **Isognomon Chemnitzianum** d'Orbigny
Tablet 683, vial containing 8 doubles.—684, vial containing 3 doubles.—684*, vial containing 3 doubles.—685, 1 double. —686, 1 double.—687, 5 doubles.—688, 2 young sp. in *Balanus* and in *Patella Mexicana.*—688, duplicate, young in dead *Balanus.*

206 **Isognomon Janus,** n.s.
Tablet 689, 1 double and 2 single valves, young in vial. 690, 1 double.

207 **Pecten circularis** Sowerby
Tablet 691, —.

208 **Spondylus calcifer,** n.s.
Tablet 692, —. 693, —. 694, —. 695, —. 696, 1 very large sp.—697, 3 sp. bored by annelids.—697, duplicate, 5 fragments.—698, 1 fragment.—699, fragment, orange red color.

209 ? **Spondylus** ———, sp. ind.
Tablet 700, —.

210 **Plicatula penicillata,** n.s.
Tablet 701, 1 sp. on *Murex regius.*

211 **Ostrea iridescens** Gray
Tablet 702, 2 sp.—702, duplicate, vial with 3 sp.—703, 1 large sp.—704, —. 705, 1 large double, open.

212 **Ostrea Virginica** Gmelin
Tablet 706, —. 707, —. 708, 1 double open. Duplicate glass, with group of 3 sp.—709, —. 710, —. 711, —.

213 **Ostrea Columbiensis** Hanley
Tablet 712, —. 713, 1 sp. (side broken). —714, 1 double.

214 **Ostrea conchaphila,** n.s.
Tablet 715, 2 sp. and vial containing 9 young. 716, *Anomia lampe* with young oysters. 717, —. 718, on *Anomia lampe.* 719, —. 720, —. 722, —. 723, 3 doubles on *Anomia lampe* with *Ostrea conchaphila* with "Vermiliæ." 724, on *Uvanilla unguis* and *Crepidula aculeata.*—725, on *Conus regularis.*—726, —. 727, —. 728, on *Pinna.* —729, on *Murex* ? *recurvirostris.* —730, —. 731, —. 732, on *Vitularia salebrosa.* —733, several on *Arca tuberculosa.* —734, on *Modulus.*

214b **Ostrea** ?? **conchaphila** var. **palmula**
Ostrea palmula Carpenter, Hertlein and Strong, 1946, Zoologica, New York Zool. Soc., v. 31, pt 2, p. 55, pl. 1, fig. 14, photo of holotype.
Tablet 735, —. 736, —. 737, —.

215 **Ostrea** ———, sp. ind.
Tablet 738, 1 sp.—739, —. 740, —. 741, —. 742, —. 743, —. 743, 2 sp.—744, 1 double.

216 **Placunanomia pernoides,** n.s.
Tablet 745, —. 746, —. 747, 1 sp.—748, —.

217 **Placunanomia foliata** Broderip
Tablet 749, 1 valve.

218 **Placunanomia claviculata,** n.s.
Tablet 750, 1 valve.

219 **Anomia lampe** Gray
Tablet 751, 1 valve; duplicate with vial containing young.—752, 7 doubles.—753, 2 doubles.—754, 3 doubles.—755, 2 doubles.—756, 2 doubles.—757, 2 doubles.—758, 1 double.—759, 2 doubles.—760, 1 double.—761, 1 double.—762, 1 sp.—763, 1 double.—764, 1 double.—765, 2 doubles.—766, 1 sp.—767, —. 768, 1 sp.—769, 2 doubles.—770, 2 doubles.—771, 3 doubles.—772, 3 doubles.—773, 4 doubles.—774, 2 doubles.—775, 1 young sp. (broken).—776, 1 sp. with many "rows of egg cases."—777, 1 single.—778, 1 sp. with young attached.—779, —. 780, 5 doubles (broken).

220 ? ————, sp. ind. [*Naranio,* sp., see footnote, p. 529, B. M. Cat.]
Tablet 781, 1 sp.

221 **Cylichna luticola** C. B. Adams
Tablet 782, vial containing 1 sp.

222 **Tornatina infrequens** C. B. Adams
Tablet 783, broken sp. and vial containing 2 sp.

223 **Tornatina carinata,** n.s. Plate 1, fig. 1
Tablet 784, vial containing 4 sp., also drawing of type, B. M. sp.

224 **Bulla Adamsi** Menke
Tablet 785, 2 sp.—786, 4 sp.—787, 2 sp.

225 **Bulla ? nebulosa** Gould
Tablet 788, 1 sp.

226 **Bulla ? Quoyii** Gray
Tablet 789, vial containing 1 sp.

227 **Bulla exarata,** n.s.
Tablet 791, vial containing 2 sp.

228 **Bulla** ————, sp. ind.
Tablet 792, —.

229 **Haminea cymbiformis,** n.s. Plate 1, fig. 4
Tablet 793, vial containing 1 sp. also a drawing of type, B. M. sp.

230 **Glandina Albersi** Pfeiffer
Tablet 794, 2 sp.

231 **Glandina turris** Pfeiffer
Tablet 795, —.

232 **Orthalicus zebra** Müller
Tablet 796, 3 sp. 797, 3 sp.—798, —. 799, 2 sp. 800, 3 sp. —801, 5 sp.—802, 2 sp.—803, 1 sp.—804, 1 sp.—805, 1 sp.—806, —. —807, 1 sp.—808, 1 sp.—809, 3 sp., broken and mended by the animal.

233 **Orthalicus Ziegleri** Pfeiffer
Tablet 810, 1 sp.

234 **Orthalicus ? Mexicanus** Lamarck Plate 1, fig. 3
Tablet 811, drawing of B. M. sp.

235 **Melampus olivaceus,** n.s.
Tablet 812, 7 sp. and 2 gone. —813, 3 sp.—814, 6 sp.

236 **Aplexa aurantia,** n.s.
Tablet 815, 5 sp. (1 gone).—816, 3 sp.—817, 4 sp. and 1 gone.—818, 3 sp.—819, 2 sp.

237 **Aplexa elata** Gould
Tablet 820, 10 sp.—821, 7 sp.—822, 7 sp.—823, —.

238 **Planorbis tumens,** n.s.
Tablet 824, 1 sp.—825, 5 sp.—826, 3 sp.—827, 3 sp.—828, 2 sp.—829, 2 sp.—830, 2 sp. and 1 gone.—831, 3 sp.—832, 3 sp.

239 **Siphonaria lecanium** Philippi
Tablet 833, vial containing 1 sp.—833*, 1 sp.—834, vial containing 4 sp.—835, 2 small sp. and vial containing 5 smaller.—836, 1 sp.—837, 2 sp.—838, 1 sp.—839, 1 sp.—840, 2 sp.—841, 1 sp. and 1 gone.—842, 1 sp.—843, 1 sp.—844, 2 sp.—845, 1 sp.—846, 3 sp.—847, 2 sp.—848, 3 sp.—849, 3 sp.—850, 2 sp.—851, 1 sp.—852, 3 sp.—853, 3 sp.—854, 3 sp.—855, 3 sp.—856, 3 sp.—857, 3 sp.—858, 3 sp. (1 gone).—859, 3 sp.—860, 3 sp.—861, 5 sp.—862, 3 sp.—863, 2 sp.—864, 1 sp.—865, 2 sp.

240 **Siphonaria aequilirata,** n.s.
Tablet 866, —.

241 **Siphonaria** ————, sp. ind.
Tablet 867, —.

242 **Ianthina striulata,** nom. prov.
Tablet 868, —. 869, 3 sp.—870, 5 sp.—871, 5 sp.—872, 7 sp.—873, 5 sp.—874, 5 sp.—875, 5 sp. (1 broken) 876, 6 sp.

242b **Ianthina striulata** var. **contorta**
Tablet 877, 1 sp.

243 **Ianthina decollata,** nom. prov.
Tablet 878, 3 sp.

244 **Dentalium liratum,** n.s.
Tablet 879, vial containing 3 fragments.

245 **Dentalium hyalinum** Philippi
Tablet 880, —.

246 **Dentalium corrugatum,** n.s.
Tablet 881, —.

247 **Dentalium ? pretiosum** Nuttall (*teste* Hinds)
Tablet 882, —.

248 **Lophyrus articulatus** Sowerby
Tablet 883, 3 sp.—884, 1 sp.—885, 3 sp.—886, 3 large sp.—887, 1 sp.—888, 1 sp.—889, 1 sp. obscurely lobed.—890, 2 sp.—891, separate plates.—892, 2 sp., separate plates and 2 mantles.—893, —.

249 **Lophyrus albolineatus** Broderip and Sowerby
Tablet 894, 1 small sp.—895, 8 separate plates.—896, 2 sp.

250 **Lophyrus striato-squamosus,** n.s.
Tablet 897, —.

251 ? **Tonicia Forbesii,** n.s.
Tablet 898, —.

252 **Lepidopleurus sanguineus** Reeve
Tablet 899, sp.—900, 15 separate plates.

253 **Lepidopleurus clathratus,** n.s.
Tablet 901, vial containing 1 plate.

254 **Lepidopleurus bullatus,** n.s.
Tablet 902, vial containing 1 plate.

254b **Lepidopleurus bullatus** var. **calciferus**
Tablet 903, —.

255 ? **Lepidopleurus Mac-Andrei,** n.s.
L. Mac-Andreae, B. M. Cat., App., p. 550.
Tablet 904, vial containing 1 young sp. and 3 separate plates.

256 ? **Lepidopleurus Beanii,** n.s.
Tablet 905, —.

257 **Chiton flavescens,** n.s.
Tablet 906, 1 sp. on *Spondylus calcifer.*

258 **Acanthochites arragonites,** n.s.
Tablet 907, vial containing 3 sp.

259 **Patella Mexicana** Broderip and Sowerby
Tablet 908, 1 large sp.—909, 1 sp.—910, 1 sp.—911, 1 sp. the largest.

260 **Patella pediculus** Philippi
Tablet 913, 3 young sp., 2 in vial and 1 outside.—914, 3 sp.—915, 2 sp.—916, 2 sp.—917, 2 sp.—918, 2 sp.—919, 1 sp.—920, 2 sp.—921, 1 sp.—922, 1 sp. with place of attachment of *P. pediculus.*

261 **Patella discors** Philippi
Tablet 923, 3 sp.—924, 4 sp.—925, 5 sp.—926, 3 sp.—927, 3 sp.—928, 5 sp.—929, 2 sp.—930, 5 sp.—931, 5 sp.—932, 5 sp.—933, 5 sp.—934, 5 sp.—935, 5 sp.—936, 5 sp.—937, 3 sp.—938, 5 sp.—939, 5 sp.—940, 3 sp.—941, 3 sp.—942, 5 sp.—943, 1 large sp. with large *Balanus.*

262 **Nacella** ————, sp. ind.
Tablet 944, —.

263 **Acmaea mesoleuca** Menke
Tablet 945, 14 sp.—946, 12 sp.—947, 12 sp.—948, 7 sp.—949, 7 sp.—950, 5 sp.—951, 1 sp.—952, 5 sp.—953, 4 sp. and 1 gone.—954, 7 sp.—955, 5 sp.—956, 12 sp.—957, 13 sp.—958, 12 sp.—959, 7 sp.—960, 12 sp.—961, 7 sp.—962, 9 sp.—963, 7 sp.—964, —965, 6 sp.—966, 5 sp.—967, 2 sp.—968, 4 sp.—969, 7 sp.—970, 5 sp.—971, 5 sp.—972, 9 sp.—973 9 sp.—974, 9 sp.—975, 10 sp.—976, 9 sp.—977, 7 sp.—978, 12 sp.—979, 5 sp.—980, 5 sp.

264 **Acmaea fascicularis** Menke
Tablet 981, vial containing 5 sp.—982, vial containing 5 sp.—983, vial containing 1 sp.—984, 5 sp.—985, 5 sp.—986,

5 sp.—987, 5 sp.—988, 5 sp.—989, 5 sp.—990, 5 sp.—991, 5 sp.—992, 5 sp.—993, 3 sp.—994, 5 sp.—995, 7 sp.—996, 7 sp.—997, 7 sp.—998, 5 sp.—999, 5 sp.—1000, 5 sp.—1001, 5 sp.—1002, 2 sp.—1003, 5 sp.—1004, 3 sp.—1005, 3 sp.

265 **Acmaea patina** Eschscholtz
Tablet 1007, 1 sp.

266 **Acmaea persona** Eschscholtz
Tablet 1008, —.

267 **Acmaea scabra** Nuttall
Tablet 1009, 1 sp.

268 **Acmaea mitella** Menke
Tablet 1010, vial containing 5 young.—1011, 2 young sp.—1012, 17 sp.—1013, 4 sp.—1014, 1 sp., "Attachment marks of Acmaea mitella on *Patella discors*."—1015, 1 sp.

269 **Scutellina navicelloides,** n.s.
Tablet 1016, —.

270 **Gadinia pentegoniostoma** Sowerby
Tablet 1017, 3 sp.—1018, 5 sp.—1019, 2 sp.—1020, 6 sp.—1021, 2 sp.—1022, 2 sp. "one with double margin, the other extremely depressed."—1023, —.

271 **Fissurella virescens** Sowerby
Tablet 1024, 11 sp.—1025, 3 sp.—1026, 3 sp.—1027, 3 sp.—1028, —. —1029, 1 sp., 1 gone. —1030, 2 sp.—1031, 1 sp.—1032, 5 sp.—1033, 2 sp. "diseased from worms." —1034, —. 1035, —. 1036, —. 1037, —.

[272 **Fissurella Barbadensis** Gmelin
Tablet 1038, —.]

273 **Fissurella rugosa** Sowerby
Tablet 1039, vial containing 1 sp.—1040, 3 sp.—1041, 3 sp.—1042, 2 sp.—1043, 2 sp.—1044, 1 sp.—1045, 3 sp.—1046, 3 sp.—1047, 3 sp.—1048, 5 sp.—1049, 5 sp.—1050, 5 sp.—1051, 1 sp., 1 gone.—1052, 5 sp.—1053, 4 sp.—1054, 1 sp.—1055, 3 sp.

274 **Fissurella nigrocincta,** n.s.
Tablet 1056, —.

275 **Fissurella** ————, sp. ind.
Tablet 1057, —.

276 **Fissurella alba,** n.s.
Tablet 1058, 6 sp.—1059, 2 sp.—1059*, 1 sp.—1060, 2 sp.—1061, 2 sp.—1062, 6 sp.—1063, 3 sp. "with singular growth of coralline."—1064, 2 sp., "with *Acmaea mitella in situ.*"—1065, 1 sp. "with dried animal adherent." —1066, 2 sp. "hole abnormally produced." —1067, 3 sp. "with Balani." —1068, 3 sp. "distorted growth."

277 **Fissurella Peruviana** Lamarck
Tablet 1069, —.

278 **Fissurella spongiosa,** n.s.
Tablet 1070, 1 sp.

279 **Glyphis inaequalis** Sowerby
Tablet 1071, —. 1072, 3 sp.—1073, 3 sp.—1074, 7 sp. —1075, 4 sp.—1076, 1 sp.—1077, 2 sp.

280 **Glyphis alta** C. B. Adams
Tablet 1078, —. 1079, —.

281 **Rimula Mazatlanica,** n.s.
Tablet 1080, vial containing 1 young sp.

282 **Callopoma (Turbo) fluctuosum** Mawe
Tablet 1081, 2 sp.—1082, 3 sp.—1083, 6 opercula.

283 **Phasianella perforata** Philippi
Tablet 1084, 4 sp.

283b **Phasianella** ? **perforata** var. **striulata**
Tablet 1085, 2 sp. (1 broken).

284 **Phasianella compta** Gould ms.
Tablet 1086, vial containing 2 sp.

285 **Bankivia varians** *jun.* Beck
Tablet 1087, —.

286 **Uvanilla (Imperator) olivacea** Mawe
Tablet 1088, —. 1089, 5 sp.—1090, —. 1095, —. [Many specimens but glass broken before 1945, so that tablet No. could not be determined.]

287 **Uvanilla inermis** Gmelin
Tablet 1096, 1 sp.

288 **Uvanilla unguis** Mawe
Tablet 1097, 5 sp.—1098, 6 sp.—1099, 4 sp.—1100, 3

sp.—1101, 1 sp. "curiously mended after fracture." 1102, 1 sp. —1103, —. 1104, 2 sp. "covered with algae."—1105, —. 1106, —. 1107, 3 sp.—1108, 1 sp.—1109, 1 sp.—1110, 3 sp.—1111, 3 sp. "irregularly developed," 1 gone.—1112, 2 sp.—1113, 2 sp.—1114, 1 sp. with operculum.—1115, 1 sp. "with attachment outside of mouth."—1116, 1 sp.—1117, 3 opercula.

289 **Trochus versicolor** Menke

Tablet 1118, 5 sp.—1119, 3 sp.—1120, 7 sp.—1121, 2 sp. "with hermit crabs."—1122, sp. [no operculum.]—1123, 5 sp. —1124, 5 sp.—1125, 3 sp.—1126, 3 sp.—1127, 5 sp.—1128, 3 sp.

290 **Trochus Mac-Andreae,** n.s.

Tablet 1129, vial containing 1 sp.

291 **Omphalius ? rugosus** var. **rufotinctus**

Tablet 1130, 1 large sp.—1131, 1 sp.

292 **Omphalius viridulus** Gmelin

Tablet 1132, —.

293 **Omphalius ligulatus** Menke

Tablet 1133, 3 sp.—1134, 5 sp.—1135, 5 sp.—1136, 3 sp. —1137, 3 sp.—1138, 3 sp.—1139, 3 sp.—1140, 3 sp.—1141, 2 sp. "curiously mended after fracture."—1142, 4 sp. "with Bryozoa and annelids attached."—1143, 1 sp. with attachment at base.

294 **Omphalius globulus,** n.s.

Tablet 1145, 1 sp.

295 **Vitrinella Panamensis** C. B. Adams

Tablet 1146, —.

296 **Vitrinella parva** C. B. Adams

Tablet 1147, vial containing 3 sp.

297 ? **Vitrinella decussata,** n.s.

Tablet 1148, vial containing 4 sp.

298 **Vitrinella monile,** n.s.

Tablet 1149, vial containing 2 sp.

299 **Vitrinella monilifera,** n.s.

Tablet 1150, vial containing 1 sp.

300 **Vitrinella lirulata**, n.s.
Tablet 1151, —.

301 **Vitrinella subquadrata**, n.s.
Tablet 1152, vial containing 2 sp.

302 **Vitrinella bifilata**, n.s.
Tablet 1153, —.

303 **Vitrinella bifrontia**, n.s.
Tablet 1154, vial containing 1 sp.

304 **Vitrinella perparva** C. B. Adams var. **nodosa**
Tablet 1155, vial containing 1 sp.

305 **Vitrinella exigua** C. B. Adams
Tablet 1156, vial containing 1 sp.

306 **Vitrinella coronata**, n.s.
Tablet 1157, vial containing 1 sp.

307 ? **Vitrinella annulata**, n.s.
Tablet 1158, —.

308 **Vitrinella cincta**, n.s.
Tablet 1159, —.

309 **Vitrinella carinulata**, n.s.
Tablet 1160, vial containing 1 sp.

310 ? **Vitrinella naticoides**, n.s.
Tablet 1161, vial containing 1 sp.

311 ? **Vitrinella planospirata**, n.s.
Tablet 1162, —.

312 ? **Vitrinella orbis**, n.s.
Tablet 1163, vial containing 1 sp.

313 ? **Liotia carinata**, n.s.
Tablet 1164, —.

314 ? **Liotia striulata**, n.s.
Tablet 1165, —.

315 ?? **Liotia C-B-Adamsii**, n.s.
Tablet 1166, —.

316 ? **Liotia** ————, sp. ind.
Tablet 1167, —.

317 ? **Globulus tumens**, n.s.
Tablet 1168, —.

317b **Globulus sulcatus**, n.s.
Tablet 1168, vial containing 1 sp. [Not listed in Albany Cat., Rep't 1860, p. 32.]

318 **Ethalia pyricallosa**, n.s.
Tablet 1169, —.

319 **Ethalia lirulata**, n.s.
Tablet 1170, vial containing 1 sp.

320 **Ethalia pallidula**, n.s.
Tablet 1171, —.

321 **Ethalia carinata**, n.s.
Tablet 1172, sp. gone.

322 **Ethalia amplectans**, n.s.
Tablet 1173, vial containing 1 sp.

323 **Teinostoma amplectans**, n.s.
Tablet 1174, vial containing 1 sp.

324 **Teinostoma substriatum**, n.s.
Tablet 1175, vial containing 1 sp.

325 **Trochus** ————, sp. ind.
Tablet 1176, —.
Tablets 1177-80, —.

326 **Nerita scabricosta** Lamarck
Tablet 1181, 3 sp.—1182, 1 sp. and operculum mounted separately.—1183, 1 sp.—1184, 2 sp. with operculum of each mounted separately. —1185, 2 sp. with an operculum mounted separately. —1186, 1 sp. with opercula mounted separately. 1187, 1 sp. with opercula mounted separately. —1188, 1 sp. —1189, 1 sp.—1190, 1 sp.—1191, 1 sp. with opercula.—1192, 2 sp. with opercula, 3d sp. gone.

327 **Nerita Bernhardi** Récluz
Tablet 1193, 7 sp.—1194, 7 sp.—1195, 5 sp. with opercula in place. —1196, 5 sp.—1197, 5 sp.—1198, 7 sp.—1199, 7 opercula.

328 **Neritina cassiculum** Sowerby
Tablet 1200, 3 sp. with an operculum separately. —1201,

3 sp.—1202, 5 sp.—1203, 7 sp. with an operculum separately. —1204, 2 sp.—1205, 3 sp.—1206, 1 sp. with opercula separately. —1207, 5 sp. with an operculum separately. —1208, 5 opercula.

329 **Neritina picta** Sowerby

Tablet 1209, 6 sp.—1210, 5 sp.—1211, 5 sp.—1212, 5 sp. —1213, 3 sp.—1214, 3 sp.—1215, 3 sp.—1216, 2 sp.—1217, 1 sp.—1218, 3 sp.—1219, 1 sp.—1220, 1 sp.—1221, 3 sp.—1222, 3 sp.—1223, 3 sp.—1224, 3 sp.—1225, 3 sp.—1226, 5 sp.—1227, 3 sp.—1228, 3 sp.—1229, 3 sp.—1230, 2 sp.—1231, 3 sp.—1232, 1 sp.—1233, 1 sp.—1234, 1 sp. 1235, 3 sp. —1236, 3 sp.—1237, 3 sp.—1238, 3 sp.—1239, 3 sp.—1240, 3 sp.—1241, 2 sp.—1242, 2 sp.—1243, 3 sp.—1244, 2 sp.—1245, 2 sp.—1246, 2 sp. and opercula. —1247, 2 sp.—1248, 2 sp.—1249, 1 sp.—1250, 3 sp.—1251, 3 sp.—1252, 5 sp.—1253, 3 sp.—1254, 2 sp. 3d gone. —1255, 3 sp.—1256, 3 sp.—1257, 5 sp.—1258, 5 sp.—1259, 3 sp.—1260, 3 sp.—1261, 5 sp.—1262, 5 sp.—1263, 2 sp., 3d gone. —1264, 2 sp., 3d gone. —1265, 3 sp.—1266, 3 sp.—1267, 3 sp., one with dark upper body whorl and spire.—1268, 3 sp.—1269, 3 sp.—1270, 5 sp.—1271, 2 sp., 3d gone.—1272, 3 sp.—1273, 3 sp.—1274, 3 sp.—1275, 3 sp.—1276, 4 sp. [one may not belong]—1277, 2 sp.—1278, 3 sp.—1279, 2 sp. with wide band. —1280, 2 sp. with wide white band. —1281, 2 sp. —1282, 1 sp. with wide white band. —1283, 1 sp. with white band. —1284, 2 sp., 3d gone. —1285, 1 sp.—1286, 3 sp. —1287, 2 sp. wide white band. —1288, 2 sp. with wide white band. —1289, 1 sp.—1290, 3 sp. with wide white band.—1291, 1 sp.—1292, 2 sp. —1293, 1 sp. with wide white band. —1294, 1 sp.—1295, 2 sp. —1296, 3 sp.—1297, 2 sp.—1298, 1 sp.—1299, 1 sp.—1300, 1 sp.—1301, 1 sp.—1302, 3 sp.—1303, 3 sp.—1304, 3 sp.—1305, 3 sp. with dark and light spire.—1306, 2 sp. with wide band "lilac tinged."—1307, 1 sp.—1308, 1 sp.—1309, 1 sp.—1310, 5 sp.—1311, 7 sp.—1312, 11 opercula, 12th gone.

330 **Varicoro cryptophila,** n.s.

Tablet 1313, 1 sp.—1314, vial containing 7 small sp.—1315, —.

331 **Trochita ventricosa,** n.s.

Tablet 1316, —.

332 **Galerus conicus** Broderip
Tablet 1317, 4 sp.

333 **Galerus mamillaris** Broderip
Tablet 1318, part of 1 sp. = *C. regularis* and *C. Lamarckii.* —1318, 6 sp. white. —1319, 7 light sp. —1320, 1 large sp.

334 **Crepidula aculeata** Gmelin
Tablet 1321, vial containing 12 sp.—1322, vial containing 6 sp.—1323, —. 1324, 7 sp.—1325, 7 sp.—1326, 7 sp.—1327, 5 sp.—1328, 1 sp.—1329, 1 sp.—1330, 5 sp.—1331, 2 sp.—1332, 2 sp., 3d gone. —1333, 3 sp.—1334, 4 sp.—1335, 2 sp. —1336, 2 sp.—1337, 2 sp.—1338, 1 sp.—1339, —. 1340, 2 sp. —1341, 1 sp.—1342, 2 sp.—1343, 4 sp.—1344, 1 sp.—1345, 5 sp.—1346, 5 sp.—1347, 3 sp.—1348, 5 sp. with irregular growth. —1349, 4 sp.—1350, 1 sp.—1351, 1 sp.—1352, 1 sp.

335 **Crepidula dilatata** Lamarck
Tablet 1353, —.

336 **Crepidula ? dorsata** Broderip var. **bilobata**
Tablet 1354, vial containing 3 sp.

337 **Crepidula excavata** Broderip
Tablet 1355, 2 sp., young and adult. 1356, —.

338 **Crepidula adunca** Sowerby
Tablet 1357, 1 young sp. —1358, 1 sp.—1359, —. 1360, 1 sp. 1361, —.

339 **Crepidula incurva** Broderip
Tablet 1362, —. 1363, —. 1364, 2 sp. —1365, 2 sp. ? 1366, 1 sp.—1367, 1 sp.—1368, 1 sp.—1369, 3 sp.—1369*, 2 sp. in vial.—1370, 4 sp. "different ages, deeply angulated.——1371, 2 sp.—1372, 1 sp.—1373, 1 sp.—1374, 1 sp.—1375, 2 sp.—1376, 1 sp.—1377, 1 sp.—1378, —. 1379, —. 1380, 1 sp. with Bryozoa. 1381, 1 sp.—1382, 1 sp.—1383, 1 sp.—1384, 1 sp.—1385, 1 sp.—1386, 3 sp.—1387, —.

340 **Crepidula onyx** Sowerby
Tablet 1388, vial containing 4 young sp.—1389, 2 sp.—1390, 1 sp.—1391, 1 sp. with irregular margin.—1392, 1 sp. "twisted apex lateral." —1393, 1 large sp.—1394, 1 sp.—1395, —. 1396, 2 sp. var. *Lessonii.*

341 **Crepidula nivea** C. B. Adams
Tablet 1397, 2 flat sp.; 3 young sp. in vial.—1398, 11 sp.—

1399, 5 sp.—1400, 7 sp.—1401, 8 sp.—1402, 3 sp. "with broad laminated margin." 1403, 2 sp.—1404, 2 sp. (1 very large.)—1405, 2 sp.—1406, 4 sp.—1407, 1 sp. *"Lessonii* var." —1408, 2 sp.—1409, 2 sp. on *Serpula.*—1410, 2 sp., longitudinally ribbed. 1411, 3 sp. very irregular margin. —1412, 1 sp.—1413, 1 sp.—1414, 3 sp.—1415, 2 sp.—1416, 1 sp.—1417, 1 sp.—1418, 1 large sp.—1419, 1 sp.—1420, 1 large sp. —1421, —. 1422, 3 sp.—1423, —. 1424, —. 1425, 1 sp. "from burrow of *Lithophagus* in *Spondylus calcifer."* —1426, 4 sp. —1427, 5 sp.—1428, 1 sp.—1429, —.

342 **Crepidula ? unguiformis** Lamarck
Tablet 1430-31, 1 sp.

343 **Crucibulum imbricatum** Sowerby
Tablet 1432, 1 young sp.—1433, 3 sp.—1434, 2 sp.—1435, 2 sp.—1436, 3 sp. (fine).—1437, 4 sp. (fine).—1438, 3 sp.—1439, 1 sp.—1440, 3 sp.—1441, —. 1442, —. 1443, 2 sp. *Uvanilla* with *Calyptraea* attached. —1444, 5 sp.

344 **Crucibulum spinosum** Sowerby
Tablet 1445, 1 sp. in vial. —1446, 3 sp. (1 gone). —1447, 5 sp.—1448, 1 sp.—1449, 3 sp.—1450, 3 sp.—1451, 2 sp.—1452, 1 sp. var. *quiriquinia.*—1453, 4 sp.—1454, 3 sp.—1455, 3 sp.—1456, 2 sp. "spines greatly developed." —1457, 2 sp. —1458, 4 sp.—1459, 4 sp.—1460, 2 sp.

345 **Calyptraea cepacea** Broderip
Tablet 1461, 1 sp.

346 **Hipponyx serratus,** n.s.
Tablet 1462, —. 1463, 1 sp. of *Hipponyx* and *"Byssoarca solida."* —1464, 1 sp.—1465, 2 sp., 1 flat and 1 conical. 1466, —. 1467, —. 1468, 1 sp.

347 **Hipponyx antiquatus** Linnaeus
Tablet 1469, —.

348 **Hipponyx planatus,** n.s.
Tablet 1470, 1 sp.

349 **Hipponyx barbatus** Sowerby
Tablet 1471, vial containing 5 sp.—1472, "attached lamina of *H. barbatus* on fragment of *Spondylus calcifer."* 1472, (duplicate) 3 sp.—1473, 1 small sp.

350 **Hipponyx (Amathea) Grayanus** Menke
Tablet 1474, 1 sp.

351 **Capulus** ———, sp. ind.
Tablet 1475, —.

352 **Aletes centiquadrus** Valenciennes
Tablet 1476, —. 1477, —. 1478, —. 1479, 12 fragments. —1480, —. 1481, 3 sp. off *Spondylus calcifer*. —1482, large sp. off *S. calcifer;* 2 small fragments. 1483, operculum in vial. [Also 1510 on same glass.]

352b **Aletes ? centiquadrus** var. **imbricatus**
Tablet 1484, 1 sp. on *Uvanilla unguis.*

353 **Aletes margaritarum** Valenciennes
Tablet 1485, —.

354 **Vermetus eburneus** Reeve
Tablet 1486, 4 sp. in vial. —1487, 2 sp.—1488, —.

?355 **Bivonia contorta,** n.s.
Tablet ? 1489, 1 sp. in vial. —1490, 1 sp. on "*Gadinia pentegoniostoma.* —1491, 1 sp. on fragment of "*Spondylus calcifer.*" —1492, 1 sp. on "*Uvanilla unguis.*" —1493, 2 sp. off *S. calcifer.*

355b ? **Bivonia ? contorta** var. **indentata**
Tablet 1494, 1 sp.

356 ? **Bivonia albida,** n.s.
Tablet 1495, 1 sp. in vial.

357 ? **Bivonia** ———, sp. ind. (*a*)
Tablet 1496, —. 1497, 1 sp. on *Conus gladiator.*

?358 ?? **Bivonia** ———, sp. ind. (*b*)
Tablet 1498, 1 sp. in vial.

359 **Petaloconchus macrophragma,** n.s.
Carpenter, 1856, Proc. Zool. Soc. London, pt. XXIV, p. 313, fig. 1 of section only.
Tablet 1499, 5 fragments in vial. —1499 (duplicate), 9 sp. —1500, 1 sp. on "*Murex princeps.*" 1501, 2 sp. of *Uvanilla olivacea* with several sp. attached. —1502, 2 sp. on "*Uvanilla unguis.*" —1503, 2 sp. on "*Leucozonia cingulata.*" 1504, 2 sp. on "*Cuma costata.*" 1505, —. 1506, 1 sp. on "*Pisania insignis.*"

Opercula of Vermetidae
1507, —. 1508, —. 1509, —. 1510, 1 sp. on glass with 1483. —1511, —. 1512, 2 sp. in vials. —1513, —.

360 **Caecum insculptum,** n.s.
Tablet 1514, 1 sp. in vial.

361 **Caecum subspirale,** n.s.
Tablet 1515, vial with 3 sp.

362 **Caecum abnormale,** n.s.
Tablet 1516, vial with 1 sp.

363 **Caecum obtusum,** n.s.
Tablet 1517, vial with 1 large sp.

364 **Caecum liratocinctum,** n.s.
Tablet 1518, vial containing 7 sp.—1519, vial containing 1 sp.—1520, vial containing 1 sp.

var. **tenuiliratum**
Tablet 1520, vial containing 1 sp.

var. **subobsoletum**
Tablet 1521, —.

var. **subconicum**
Tablet 1522, —.
Tablet 1523, —.

365 **Caecum heptagonum,** n.s.
Tablet 1524, —.

366 **Caecum elongatum,** n.s.
? var. **semilaeve**
Tablet 1525, vial containing 2 sp.—1526, vial containing 1 sp.

367 **Caecum subimpressum,** n.s.
Tablet 1527, vial containing 2 sp.

368 **Caecum firmatum** C. B. Adams
Tablet 1526, vial containing 5 sp. [Duplicate Tablet No. 1526, see also Species 366.]

369 **Caecum clathratum,** n.s.
Tablet 1528, vial containing 3 sp.

370 **Caecum quadratum,** n.s.
? var. **compactum**

Tablet 1529, vial containing 4 sp.—1530, vial containing 2 sp. (compactum).

371 **Caecum undatum,** ? n.s. Plate 1, fig. 19 (group)
Carpenter, 1857, Rep't 26th Meeting Brit. Assoc. Adv. Sci., p. 256, pl. 9, figs. 4 a- 4 o; 1858, Proc. Zool. Soc. London, p. 430.
Tablet 1531, vial containing 4 sp.—1532, vial containing 7 sp.—1533, vial containing 4 sp.—1534, vial containing 7 sp. —1535; vial containing 4 sp.—1536, vial containing 4 sp.— 1537, vial containing 3 sp.—1538, vial containing 3 sp.; magnified drawings of 15 syntypes (B.M. sp.) progressive sp. to show life history.

372 **Caecum laeve** C. B. Adams
Tablet 1539, vial containing 5 sp.—1540, vial containing 3 sp.—1541, vial containing 2 sp.—1542, vial containing 4 sp. —1543, vial containing 1 sp. with operculum.

373 **Caecum farcimen,** n.p.
Tablet 1544*, vial containing 1 sp. Duplicate vial containing 3 sp. 1545, —.

374 **Caecum glabiforme,** n.s.
Tablet 1546, vial containing 1 sp.

375 **Caecum corrugulatum,** n.s.
Tablet 1547, vial containing 1 sp.

376 **Caecum dextroversum,** n.s.
Tablet 1548, vial containing 4 sp.—1548* vial with 1 sp.

377 **Caecum reversum,** n.s.
Tablet 1549, —.

378 **Caecum teres,** n.s.
Tablet 1550, vial containing 1 sp. "Pseudo-caecous bodies" —Tablet 1551, —.

379 **Turritella goniostoma** Valenciennes
Tablet 1552, 5 sp.—1553, —. 1554, 1 sp.—1555, 1 sp. 1556, 1 sp.—1557, 3 sp.—1558, 3 sp.—1559, 2 sp. (1 gone). 1560, 1 sp.—1561, 2 sp.—1562, 2 sp.—1563, 2 sp.—1564, 1 sp.— 1565, 2 sp.—1566, 3 sp.—1567, 1 sp.—1568, 2 sp.—1569, 2 sp.—1570, 1 sp.—1571, —.

380 **Turritella tigrina** Kiener
Tablet 1572, vial containing young and fragments of young, 4 sp.—1573, 3 sp.—1574, 2 sp.

381 **Cerithium maculosum** Kiener
Tablet 1575, 1 sp.—1576, 3 sp.—1577, 3 sp.—1578, 3 sp. —1579, 3 sp.—1580, 3 sp.—1581, 3 sp.—1 separate operculum.—1582, 3 sp.—1583, 3 sp., 1 separate operculum.—1584, 3 sp. with fractures repaired by animal.—1585, 2 sp.—1586, 9 opercula (1 gone).

382 **Cerithium ? famelicum** C. B. Adams
var. **mediolaeve**
Tablet 1587, —.

383 **Cerithium ? uncinatum** Gmelin
Tablet 1588, vial containing 1 adult and 4 young sp.—1589, —.

384 **Cerithium** ———, sp. ind. (*a*)
Tablet 1590, —.

385 **Cerithium alboliratum**, n.s.
Tablet 1591, 3 sp.

386 **Cerithium** ———, sp. ind. (*b*)
Tablet 1592, —.

387 **Cerithium stercus-muscarum** Valenciennes
Tablet 1593, 7 sp.—1594, 7 sp.—1595, 3 sp.—1596, 2 sp. "lob-sided." —1597, 1 sp.—1598, 1 sp.—1599, 1 sp. with fracture mended by animal. —1600, 1 sp. bored by gastropod. —1601, 7 sp. (1 gone).

388 **Cerithium interruptum** Menke
Tablet 1602, 1 sp. adult with operculum, 1 young in vial. —1603, 5 sp.—1604, vial containing 3 opercula.

389 **Vertagus gemmatus** Hinds
Tablet 1605, 6 sp.—1606, 2 sp.—1607, 7 sp.—1608, 5 sp. 1609, 4 sp.—1610, 2 sp.—1611, —. 1612, 5 opercula in vial.

390 **Vertagus** ———, sp. ind.
Tablet 1613, —.

391 **Triforis alternatus** C. B. Adams
Tablet 1614, vial with 2 sp., young and adult.

392 **Triforis inconspicuus** C. B. Adams
Tablet 1615, vial with 3 sp.

393 **Triforis ? infrequens** C. B. Adams
Tablet 1616, vial containing fragment of young sp.

394 **Cerithidea Montagnei** d'Orbigny
Tablet 1617, 7 sp.—1618, 5 sp., dwarf state. —1619, 5 sp. —1620, 2 sp.—1621, 5 sp.—1622, —. 1623, 2 sp.—1624, 3 sp. —1625, 3 sp. —1626, 3 sp. with very thick varix. —1627, 1 sp. and 3 opercula.

395 **Cerithidea ? varicosa** Sowerby var. **Mazatlanica**
Tablet 1628, 5 sp.—1629, 5 sp.—1630, 5 sp.—1631, 3 sp. —1632, 5 sp.—1633, 5 sp.—1634, 2 sp.—1635, 2 sp.—1636, 2 sp. mended by animal after fracture. —1637, 1 sp. and vial with 4 opercula.

396 **Litorina conspersa** Philippi
Tablet 1638, 7 sp.—1639, 7 sp.—1640, 7 sp.—1641, 4 sp. (1 gone) —1642, 7 sp.—1643, 7 sp.—1644, 7 sp.—1645, 11 sp.—1646, 5 sp.—1647, 6 sp.—1648, 7 sp.—1649, 7 sp.—1650, 5 sp.—1651, 3 sp.—1652, 3 sp.—1653, 3 sp.—1654, 3 sp. —1655, 4 sp.—1656, 9 opercula.

397 **Litorina aspersa** Philippi
Tablet 1657, 3 sp.—1658, 5 opercula. —1659, 4 sp.—1660, 5 sp.—1661, 3 sp.—1662, 2 sp.—1663, 1 sp.—1664, 2 sp.—1665, 2 sp.—1666, 6 sp.—1667, 2 sp.—1668, 3 sp.—1669, 4 separate opercula. —1669, duplicate 1 sp. (2 gone) [not as labeled].

398 **Litorina Philippi,** n.s.
Tablet 1671, 3 sp.—1672, 3 sp.—1673, 3 sp.—1674, 5 sp.—1675, 5 sp.—1676, 3 sp.—1677, 3 sp.—1678, 5 sp.—1679, 5 sp. with elongate stripes.—1680, 3 sp.—1681, 3 sp.—1682, 4 sp.—1683, 3 sp.—1684, 5 sp.—1685, 9 opercula in vial.

399 **Litorina** ————, sp. ind. = **L. pullata** Carpenter, 1864
L. pullata Carpenter 1864, Ann. Mag. Nat. Hist., 3d ser., v. XIII, p. 477.
Tablet 1686, 1 sp.

400 **Litorina fasciata** Gray
Tablet 1687, 2 sp.

401 **Modulus catenulatus** Philippi
Tablet 1688, 3 sp.—1689, 4 sp.—1690, 2 sp. (1 gone). —1691, 3 sp.—1692, 2 sp.—1693, 3 sp.—1694, 3 sp.—1695, 3 sp.—1696, 1 sp. with 2 Ostrea fixed. —1697, 1 operc. in vial.

402 **Modulus** ————, sp. ind.
Tablet 1698, —.

403 **Modulus disculus** Philippi
Tablet 1699, 1 adult sp.

404 **Fossarus tuberosus,** n.s.
Tablet 1700, 1 sp. in vial.

405 **Fossarus angulatus,** n.s.
Tablet 1701, 1 sp. in vial.

406 **Isapis maculosa,** n.s.
Tablet 1702, 1 sp. in vial.

407 ? **Isapis** ————, sp. ind.
Tablet 1703, —.

408 **Rissoina stricta** Menke
Tablet 1704, 4 sp. in vial.

409 **Rissoina** ————, sp. ind.
Tablet 1705, —.

410 **Rissoina Woodwardi,** n.s.
Tablet 1706, 8 sp. in vial. —1707, 5 sp. in vial.

411 ? **Rissoa lirata,** n.s.
Tablet 1708, 1 perfect sp. in vial.

412 ? **Alvania excurvata,** n.s.
Tablet 1709, 11 sp. in vial.

413 **Alvania effusa,** n.s.
Tablet 1710, —.

414 **Alvania tumida,** n.s.
Tablet 1711, 1 sp. in vial.

415 ? **Alvania** ————, sp. ind.
Tablet 1712, —.

416 ? **Cingula** ————, sp. ind.
Tablet 1713, —.

417 **Hydrobia ulvae** Pennant
Tablet 1714, 1 sp. in vial.

418 ? **Hydrobia** ————, sp. ind.
Tablet 1715, —.

419 **Jeffreysia * bifasciata,** n.s.
Rissoella bifasciata (Carpenter), Bartsch, 1920, Proc. U.S. Nat. Mus., v. 58, p. 162, pl. 12, fig. 2, drawing of type.
Tablet 1716, 4 sp. in vial. —1717, 3 sp. in vial.

420 ? **Jeffreysia Alderi,** n.s.
Barleeia alderi (Carpenter), Bartsch, 1920, Proc. U.S. Nat. Mus., v. 58, p. 175, pl. 12, fig. 6, drawing of type ? Discrepancy between text and explanation of plate as to specimen figured, see p. 176.
Tablet 1718, 1 sp. in vial.

421 **Jeffreysia tumens,** n.s.
Rissoella tumens (Carpenter), Bartsch, 1920, Proc. U.S. Nat. Mus., v. 58, p. 160, pl. 12, fig. 1, drawing of type.

422 ? **Jeffreysia** ————, sp. ind.
Tablet 1720, 1 sp. in vial.

423 ? **Truncatella** ————, sp. ind.
Tablet 1721, —.

424 **Planaxis nigritella** Forbes
Tablet 1722, 66 sp. mounted (6 gone) ; 3 opercula. —1722b, 99 sp., 41 opercula separately.

425 **Alba supralirata,** n.s.
Tablet 1723, 5 sp. in vial.

426 **Alba violacea,** n.s.
Tablet 1724, —.

427 **Alba terebralis,** n.s.
Tablet 1725, —.

428 **Alaba alabastrites,** n.s.
Tablet 1726, —.

429 **Alaba scalata,** n.s.
Tablet 1727, —.

430 ? **Alaba conica,** n.s.
Tablet 1728, 1 sp. in vial.

431 ? **Alaba mutans,** nom. prov.
Tablet 1729, —.

432 ? **Alaba laguncula,** nom. prov.
Tablet 1730, —.

433 ?? **Alaba** ————, sp. ind. (*a*)
Tablet 1731, —.

434 ? **Alaba** ————, sp. ind. (*b*)
Tablet 1732, —.

435 **Ovula variabilis** C. B. Adams
Tablet 1733, 9 sp.

436 **Cypraea exanthema** Linnaeus
Tablet 1734, 3 sp. "adolescent, banded." —1735, 1 sp., bands evident. —1736, 1 sp. —1737, 1 sp., bands very evident, wide. —1738, 1 sp.—1739, 1 sp., light spots faint. —1740, 1 sp., spots decided. —1741, negative of photo of 1 B. M. sp.—1742, 1 sp. and negative of photo of B. M. sp.—1743, 2 sp. (the smaller, *cervinetta*) ; 2 negatives of photo of B. M. sp.—1744, 3 sp., showing variations in aperture, narrow to broad. —1745, 3 sp., beautiful. —1746, 1 sp., fracture mended by animal. —1747, —.

437 **Luponia ? spurca** Linnaeus
Tablet 1748, negative of photo of B.M. sp. [Poor negative.]

438 **Aricia arabicula** Lamarck
Tablet 1749, 1 sp.—1750, 3 sp.—1751, 3 sp.—1752, 3 sp.—1753, 3 sp.—1754, 5 sp.—1755, 3 sp.—1756, 3 sp.—1757, 1 sp.—1758, 2 sp.—1759, 1 sp., pale, "uniform greenish yellow without spots." —1760, 3 sp.—1761, 3 sp.—1762, 1 sp.—1763, 3 sp.—1764, 2 sp.—1765, 3 sp.—1766, 5 sp.—1767, 3 sp.—1768, 3 sp.—1769, 3 sp.—1770, 3 sp.—1771, 5 sp.—1772, 1 sp.—1773, 3 sp.—1774, 1 sp.—1775, 5 sp.—1776, 5 sp.—1777, —. 1778, 3 sp.—1779, 3 sp. 1780, 3 sp.

439 **Trivia pustulata** Lamarck
Tablet 1781, 5 sp. and sketch of 5 sp.—1782, 5 sp.—1783, 5 sp.—1784, 5 sp.—1785, 5 sp.—1786, 3 sp. (broad). —1787, 3 sp.—1788, 3 sp.—1789, 2 sp. "showing extremes of size." —1790, 2 sp. and negatives of photos of 2 B.M. sp.

440 **Trivia radians** Lamarck
Tablet 1791, 3 sp. (broken), negatives of photos of 2 B.M.

sp.—1792, 3 sp., negatives of photos of 3 B.M. sp.—1793, 2 sp., negatives of photos of 3 B.M. sp.

441 **Trivia Solandri** Gray
Tablet 1794, 1 sp., negatives of photos of 2 B.M. sp.—1795, 4 sp.—1795*, 1 sp.

442 **Trivia sanguinea** Gray
Tablet 1796, 3 sp.—1797, 3 sp.—1798, 3 sp.—1799, 3 sp.—1800, 3 sp.—1801, 3 sp.—1802, 3 sp.—1803, 3 sp.—1804, 3 sp.—1805, 1 sp.—1806, 5 sp.—1807, 5 sp.—1808, 4 sp.—1809, 3 sp. (1 gone). 1810, negatives of photos of 2 B.M. sp.

443 **Trivia pulla** Gaskoin
Tablet 1811, —.

444 **Trivia subrostrata** Gray
Tablet 1812, —.

445 **Cancellaria urceolata** Hinds
Tablet 1813, 4 sp.

446 **Cancellaria goniostoma** Sowerby
Tablet 1814, 2 sp.—1815, 1 sp.—1816, 2 sp.—1817, 1 large sp.—1818, 3 sp.—1819, 2 sp., ribs distant.—1820, 2 sp.

447 **Strombus galeatus** Swainson
Tablet 1821. —. 1822, 1 sp. and adolescent sp. marked 1822c; [loose marked 1822b no specimen.]

448 **Strombus granulatus** Swainson
Tablet 1823, 2 sp. (larger fracture mended by animal). —1824, —.

449 **Strombus gracilior** Sowerby
Tablet 1825, 2 sp. (adolescent and adult). —1826, —. 1827, —.

450 **Myurella albocincta**, n.s.
Tablet 1828, —. 1829, 3 sp.—1830, 3 sp.—1831, 1 sp.—1832, 1 sp.—1833, 1 sp.—1834, 3 sp.—1835, 2 opercula in vial. —1835 (duplicate), 1 sp.

451 **Myurella Hindsii**, ? n.s.
Tablet 1836, 1 sp.

452 **Myurella subnodosa**, ? n.s.
Tablet 1837, 1 sp.

453 **Myurella rufocinerea**, ? n.s.
Tablet 1838, negative of photos of 2 syntypes, B.M. sp.

454 **Subula luctuosa** Hinds
Tablet 1839, 5 sp.—1840, 3 sp.—1841, 3 sp.—1842, 5 sp.—1843, 5 sp.—1844, 5 sp.—1845, 1 sp. banded light just below suture at noded area, dark below. —1846, 3 sp.—1847, 1 sp. with operculum.

455 **Euryta fulgurata** Philippi
Tablet 1848, 5 sp. white, bluish above suture. —1849, 5 sp. white. —1850, 5 sp., flesh color. —1851, 5 sp.—1852, 3 sp. banded with light and dark. —1853, 3 sp.—1854, 5 sp.—1855, 3 sp.—1856, 3 sp.—1857, 5 sp.—1858, 5 sp.—1859, 5 sp., banded light and dark. —1860, 5 sp.—1861, 1 sp.—1862, 5 sp.—1863, 5 sp.—1864, 5 sp. (1 gone)—1865, 5 sp.—1866, 5 sp.—1867, 5 sp.—1868, 5 sp.—1869, 5 sp.—1870, 5 sp.—1871, 5 sp.—1872, —. 1873, 5 sp.—1874, 5 sp.—1875, 5 sp.—1876, 5 sp.—1877, 5 sp.—1879, 5 sp. [1878 belongs to 456; duplicate 1879 belongs to 457.]

456 **Euryta aciculata** Lamarck
Tablet 1878 [number not in sequence], negative of photo of B.M. sp.

457 **Pleurotoma funiculata** Valenciennes
Tablet 1879, 4 sp.—1880, 3 sp.—1881, 4 sp.

458 **Pleurotoma maculosa** Sowerby
Tablet 1882, 5 sp.—1883, 3 sp.—1884, 2 sp.—1885, 3 sp., fracture mended by animal. —1886, 1 sp. —1887, 1 sp.—1888, 2 sp.—operculum *in situ.*

459 **Drillia incrassata** Sowerby
Tablet 1889, negative of photo of B.M. sp.

460 **Drillia rudis** Sowerby
Tablet 1890, 2 sp.

461 **Drillia aterrima** Sowerby var. **Melchersi**
Tablet 1891, 8 sp.—1892, 4 sp.—1893, 3 sp.—1894, 2 sp.—1895, 2 sp.—1896, 2 sp. and 1 operculum.

462 ? **Drillia cerithoidea,** n.s.
Tablet 1897, 1 sp.

463 **Drillia zonulata** Reeve
Tablet 1898, —.

464 **Drillia monilifera,** n.s.
Tablet 1899, 1 sp.

465 **Drillia albovallosa,** n.s.
Tablet 1900, negative of photo of type, B.M. sp. and fragment.

466 **Drillia albonodosa,** n.s.
Tablet 1901, 1 sp.

467 **Drillia luctuosa** Hinds
Tablet 1902, 3 sp.—1903, 6 sp.—1904, 2 sp. mended by animal after fracture. —1905, 1 sp.

468 ? **Drillia Hanleyi,** n.s.
Tablet 1907, negative of photo of type, B.M. sp.

469 **Drillia** ———, sp. ind.
Tablet 1908, —.

470 **Drillia** ———, sp. ind.
Tablet 1909, 1 sp.
Tablet 1910, —.
Tablet 1911, —.

471 **Clathurella rava** Hinds
Tablet 1912, 1 sp.

472 **Clathurella aurea,** n.s.
Tablet 1913, negative of photo of type, B.M. sp.

473 **Mangelia ? acuticostata** var. **subangulata**
Tablet 1914, —.

474 ? **Cithara** ———, sp. ind.
Tablet 1915, —.

475 **Conus regularis** Sowerby
Tablet 1916, 3 sp. —1917, 3 sp. —1918, 1 sp.—1919, 2 sp., color pattern shown. —1920, 1 sp.—1921, 2 sp. "after hot acid showing color pattern" —1922, operculum gone.

476 **Conus purpurascens** Broderip
Tablet 1923, 2 sp.—1924, 1 sp.

477 **Conus regalitatis** Sowerby
Tablet 1925, 1 sp.

478 [**Conus arenatus** Bruguière
Tablet 1926, —.]

479 **Conus puncticulatus** Hwass
Tablet 1927, 3 sp.—1928, 2 sp.—1929, 1 sp.—1930, 2 sp.—1931, 1 stout sp.—1932, 1 sp. shows color after hot acid. —1933, 4 sp., "mended by animal after severe fracture"; in one the canal is twisted to the right, occupying the place of the anterior sinus in *Strombus*." 1934, fragment of 1 operculum and 1 gone.

480 **Conus gladiator** Broderip
Tablet 1935, 2 sp.—1936, 3 sp.—1937, 1 sp.—1938, 2 sp. —1939, 4 sp., "mended by animal after severe fracture"; in epidermis removed." —1942, 1 sp.—1943, 5 opercula (1 gone).

481 **Conus nux** Broderip
Tablet 1944, 1 sp.—1945, 1 sp., distorted.

482 **Conus ? scalaris** Valenciennes
Tablet 1946, negative of photo of B.M. sp.

483 ?? **Conus** ———— sp. ind.
Tablet 1948, —.

484 **Torinia ? variegata** Lamarck
Tablet 1949, 1 sp.

485 **Torinia ? granosa** Valenciennes Plate 1, fig. 5
Tablet 1950, drawing of fragment, B.M. sp.

486 **Obeliscus ? conicus,** *jun.* C. B. Adams Plate 1, fig. 2
Pyramidella, sp. ind., Carpenter, 1863, Proc. Zool. Soc. London, p. 357, No. 293.
Pyramidella (*Longchaeus*) *adamsi* Carpenter, 1864, *fidé* Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 21.
Tablet 1951, drawing of B.M. sp.

487 **Odostomia sublirulata,** n.s.
Odostomia (*Menestho*) *sublirulata* Carpenter, Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 192, pl. 20, fig. 4, drawing of type.
Tablet 1952, drawing of type, B.M. sp.

488 **Odostomia ———, sp. ind.** Plate 1, fig. 6
Tablet 1953, drawing B.M. sp.

489 **Odostomia lamellata,** n.s.
Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 24.
Tablet ? 1954, vial containing sp. and drawing of broken type or composite B.M. specimens.

490 **Odostomia subsulcata,** n.s.
Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 25.
Tablet 1955, vial containing 1 sp. and drawing of syntype, B.M. sp.

491 **Odostomia vallata,** n.s.
Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 25.
Tablet 1956, vial containing 1 sp. and drawing of syntype, B.M. sp.

492 **Odostomia mammillata,** n.s. = **Diala paupercula** (C. B. Adams), Carpenter, 1863
Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 233, pl. 30, fig. 8 drawing of type.
Tablet 1957, drawing of type, B.M. sp.

493 **Odostomia tenuis,** n.s.
Odostomia (*Evalea*) *tenuis* Carpenter, Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 197, pl. 22, fig. 3, drawing of type.
Tablet 1958, vial containing specimen and drawing of type, B.M. sp.

494 **Auriculina ———**, sp. ind. (*a*)
Tablet 1959, 1 sp. in vial, fragment, nuclear whorls; drawing of nucleus and spiral whorls of B.M. sp.

495 **Auriculina ———**, sp. ind. (*b*) Plate 1, fig. 11
Tablet 1960, 1 sp. in vial and drawing of B.M. sp.

496 **Auriculina ———**, sp. ind. (*c*)
Tablet 1961, drawing of fragment, B.M. sp.

497 **Parthenia scalariformis,** n.s.
Odostomia (*Salassia*) *scalariformis* (Carpenter), Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 135, pl. 13, fig. 1, drawing of type.
Tablet 1962, drawing of syntype, B.M. sp.

498 **Parthenia quinquecincta**, n.s.
Odostomia (*Ividella*) *quinquecincta* (Carpenter), Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 174, pl. 18, fig. 1, drawing of type.
Tablet 1963, 1 sp. and drawing of type, B.M. sp.

499 **Parthenia lacunata**, n.s.
Odostomia (*Egila*) *lacunata* (Carpenter), Dall and Bartsch, U.S. Nat. Mus. Bul., No. 68, p. 170, pl. 19, fig. 1, drawing of type.
Tablet 1964, 1 sp. and drawing of type, B.M. sp.

500 **Parthenia armata**, n.s.
Odostomia (*Miralda*) *armata* (Carpenter), Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 177, pl. 19, fig. 6, drawing of type.
Tablet 1965, 2 sp. and drawing of B.M. sp.

501 **Parthenia exarata**, n.s.
Odostomia (*Miraldo*) *exarata* (Carpenter), Dall and Bartsch, U.S. Nat. Mus. Bul., No. 68, p. 170, pl. 19, fig. 2, drawing of type.
Tablet 1966, 1 sp. and drawing of type, B.M. sp.

502 **Parthenia ziziphena**, n.s.
Odostomia (*Menestho*) *ziziphena* (Carpenter), Dall and Bartsch, U.S. Nat. Mus. Bul., No. 68, p. 186, pl. 20, fig. 2, drawing of type.
Tablet 1967, drawing of type, B.M. sp.

503 **Chrysallida ovata**, n.s.
Odostomia (*Chrysallida*) *ovata* Carpenter, Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 152, pl. 15, figs. 7, *7a*, drawings of syntype.
Tablet 1968, 3 sp.

504 **Chrysallida nodosa**, n.s.
Odostomia (*Chrysallida*) *nodosa* Carpenter, Dall and Bartsch, U.S. Nat. Mus. Bul., No. 68, p. 151, pl. 15, figs. 9, 9*a*, drawing of syntype.
Tablet 1969, 2 sp.

505 **Chrysallida rotundata**, n.s.
Odostomia (*Chrysallida*) *rotundata* Carpenter, Dall and

Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 168, pl. 18, fig. 4, drawing of syntype.
Tablet 1970, 3 sp. in vial.

506 **Chrysallida oblonga,** n.s. = **C. benthina** Dall and Bartsch
Odostomia (*Chrysallida*) *benthina* Dall and Bartsch, new name, 1909, U.S. Nat. Mus. Bul., No. 68, p. 163, pl. 17, figs. 9, 9*a*, drawing of syntype.
Tablet 1971, 4 sp.

507 **Chrysallida communis** C. B. Adams = **C. torrita** Dall and Bartsch
Odostomia (*Chrysallida*) *torrita* Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 142, fig. 2 *non C. communis* C. B. Adams, 1852.
Tablet 1972, 7 sp.—1973, 5 sp.—1974, —. 1975, 9 sp.—1976, 2 sp.—1977, 9 sp.

508 **Chrysallida telescopium,** n.s.
Odostomia (*Chrysallida*) *telescopium* Carpenter, Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 139, pl. 13, fig. 9, drawing of syntype.
Tablet 1978, 1 adult and 1 young sp.

509 **Chrysallida Reigeni,** n.s.
Odostomia (*Chrysallida*) *reigeni* Carpenter, Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 138, pl. 13, fig. 7, drawing of type.
Tablet 1979, —.

510 **Chrysallida effusa,** n.s.
Odostomia (*Chrysallida*) *effusa* Carpenter, Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 144, pl. 14, figs. 5, 5*a*, drawing of type.
Tablet 1980, —.

511 **Chrysallida fasciata,** n.s.
Odostomia (*Chrysallida*) *fasciata* Carpenter, Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 165, pl. 17, fig. 2, drawing of syntype.
Tablet 1981, 2 sp.

512 **Chrysallida ovulum,** n.s. = **C. oonisca** Dall and Bartsch
Odostomia (*Chrysallida*) *oonisca* Dall and Bartsch, new

name, 1909, U.S. Nat. Mus. Bul., No. 68, p. 150, pl. 15, fig. 3, drawing of syntype.
Tablet, 1982, 11 sp.

513 **Chrysallida clathratula** C. B. Adams
Tablet 1983, —.

514 **Chrysallida convexa,** n.s.
Odostomia (*Besla*) *convexa* (Carpenter), Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 135, pl. 13, fig. 4, drawing of type.
Tablet 1984, 1 sp. in vial.

515 **Chrysallida Photis,** n.s.
Odostomia (*Haldra*) *photis* (Carpenter), Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 171, pl. 18, fig. 8, drawing of type.
Tablet 1985, 1 sp.

516 **Chrysallida indentata,** n.s.
Turbonilla (*Pyrgiscus*) *indentata* (Carpenter), Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 102, pl. 10, fig. 10, drawing of type.
Tablet ? 1986, 1 sp.

517 ?? **Chrysallida clausiliformis,** n.s.
Odostomia (*Lysacme*) *clausiliformis* (Carpenter), Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 132, pl. 13, fig. 2, drawing of type.
Tablet 1987, 2 worn and broken sp.

518 **Chemnitzia ? Panamensis** C. B. Adams
Tablet 1989, —.

519 **Chemnitzia C-B-Adamsii,** n.s.
Turbonilla (*Strioturbinella*) *C-B-Adamsii* (Carpenter), Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 52, pl. 3, fig. 3, drawing of type.
Tablet 1990, 1 sp.

520 **Chemnitzia ? similis** C. B. Adams
Tablet 1991, 1 sp.

521 **Chemnitzia aculeus** C. B. Adams
Tablet 1992, 1 sp.

522 **Chemnitzia muricata,** n.s.

Turbonilla (*Chemnitzia*) *muricata* Carpenter, Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 36, pl. 2, fig. 9, drawing of type.

Tablet 1993, 1 sp.

523 **Chemnitzia ? affinis** C. B. Adams

Tablet 1994, vial with 1 sp. of 3 whorls and the protoconch.

524 **Chemnitzia prolongata,** n.s.

Turbonilla (*Turbonilla*) *prolongata* (Carpenter), Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 33, pl. 2, fig. 18.

Tablet 1995, 1 sp.

525 **Chemnitzia gibbosa,** n.s.

Turbonilla (*Pyrgolampros*) *gibbosa* (Carpenter), Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 61, pl. 6, fig. 2, drawing of type.

Tablet 1996, —.

526 **Chemnitzia** ————, sp. ind. (*a*)

Tablet 1997, 1 sp.

527 **Chemnitzia** ————, sp. ind. (*b*)

Tablet 1998, —.

528 **Chemnitzia** ————, sp. ind. (*c*)

Tablet 1999, —.

529 **Chemnitzia** ————, sp. ind. (*d*)

Tablet 2000, —.

530 **Chemnitzia gracillima,** n.s.

Turbonilla (*Pyrgiscus*) *gracillima* (Carpenter), Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 77, pl. 7, fig. 9, drawing of type.

Tablet 2001, 1 sp. in vial.

531 **Chemnitzia undata,** n.s.

Turbonilla (*Strioturbonilla*) *undata* (Carpenter), Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 55, pl. 4, fig. 8, drawing of type.

Tablet 2002, 1 young sp.

532 **Chemnitzia flavescens,** n.s.

Turbonilla (*Pyrgiscus*) *flavescens* (Carpenter), Dall and

Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 89, pl. 8, fig. 9, drawing of type.
Tablet 2003, —.

533 **Chemnitzia terebralis,** n.s.
Tablet 2004, 1 sp.

534 **Chemnitzia tenuilirata,** n.s.
Tablet 2005, vial with 1 sp.

535 **Chemnitzia unifasciata,** n.s.
Tablet 2006, —.

536 **Dunkeria paucilirata,** n.s.
Turbonilla (*Pyrgisculus*) *paucilirata* (Carpenter), Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 129, pl. 12, fig. 10, drawing of type.
Tablet 2007, —.

537 **Dunkeria subangulata,** n.s.
Turbonilla (*Dunkeria*) *subangulata* (Carpenter), Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 124, pl. 12, fig. 11, drawing of type.
Tablet 2008, 1 sp.

538 **Dunkeria cancellata,** n.s.
Turbonilla (*Pyrgisculus*) *cancellata* (Carpenter) Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 127, pl. 12, fig. 6, drawing of type.
Tablet 2009, —.

539 **Dunkeria intermedia,** n.s.
Odostomia (*Evalina*) *intermedia* (Carpenter), Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 181, pl. 20, fig. 6, drawing of type.
Tablet 2010, 1 sp.

540 ? **Eulimella obsoleta,** n.s.
Turbonilla (*Ptycheulimella*) *obsoleta* (Carpenter), Dall and Bartsch, 1909, U.S. Nat. Mus. Bul., No. 68, p. 59, pl. 5, fig. 6, drawing of type.
Tablet 2011, drawing of type, B.M. sp.

541 **Eulimella** ————, sp. ind. (*a*)
Tablet 2012, drawing of B.M. sp.

542 **Eulimella** ———, sp. ind. (*b*)
Tablet 2013, drawing of B.M. sp.

543 **Eulimella** ———, sp. ind. (*c*)
Tablet 2014, drawing of B.M. sp.

544 ———, sp. ind. "*Niso,* sp. ind." [Albany tablet label.]
Tablet 2015, drawing of B.M. sp.

545 **Aclis fusiformis,** n.s. Plate 1, fig. 8
Tablet 2016, drawing of type, B.M. sp. and 1 sp. in vial.

546 **Aclis tumens,** n.s. Plate 1, fig. 7
Tablet 2017, drawing of type, B.M. sp.

547 **Eulima ? hastata** Sowerby
Tablet 2018, 1 sp.

548 **Eulima** ———, sp. ind. (*a*)
Tablet 2019, 2 sp. and drawing of B.M. sp.

549 **Eulima** ———, sp. ind. (*b*) Plate 1, fig. 13
Tablet 2020, drawing of B.M. sp.

550 **Mucronalia involuta,** n.s. (1865) Plate 1, fig. 12
"*Leiostraca* ? *recta* C. B. Adams," Carpenter, 1857, Mazatlan Catalogue, p. 439; Carpenter, 1860, 13th Ann. Rep't New York Cab. Nat. Hist., p. 34.
Leiostraca involuta Carpenter, 1863, Proc. Zool. Soc. London, p. 357.
Mucronalia involuta Carpenter, 1865, Proc. Zool. Soc. London, p. 272.
Bartsch, 1917, Proc. U.S. Nat. Mus. v. 53, p. 297 states the species belongs to *Odostomia.*
Tablet 2021, 1 basal fragment and drawing of type, B.M. sp.
Tablet in collection labeled "*Leiostraca involuta* Cpr."

551 **Leiostraca producta,** n.s. (1865) Plate 1, fig. 9
"*Leiostraca* ? *solitaria* C. B. Adams," Carpenter, 1857 Mazatlan Cat., p. 439; Carpenter, 1860, 13th Ann. Rep't New York Cab. Nat. Hist., p. 34.
Leiostraca producta Carpenter, 1863, Proc. Zool. Soc. London, p. 357; 1865, Proc. Zool. Soc. London, p. 273.
Tablet in Albany labeled "*L. producta* Cpr."

Melanella (Melanella) producta (Carpenter), Bartsch 1917, Proc. U.S. Nat. Mus., v. 53, p. 318, pl. 39, fig. 5, drawing of type.
Tablet 2022, 1 sp. and drawing of type, B.M. sp.

552 **Leiostraca** ———, sp. ind. (*a*) Plate 1, fig. 10
= *L. solitaria* C. B. Adams, Carpenter
Tablet 2023, drawing of B.M. sp. Tablet in Albany labeled *L. solitaria* C. B. Adams.

553 ? **Leiostraca** ———, sp. ind. (*b*)
Tablet 2024, drawing of B.M. sp.

554 **Leiostraca linearis**, n.s. Plate 1, fig. 24
Melanella (Melanella) linearis (Carpenter), Bartsch, 1917, Proc. U.S. Nat. Mus., v. 53, p. 310, pl. 36, fig. 4.
Tablet 2025, drawing of holotype, B.M. sp.

555 **Leiostraca** ? **iota** var. **retexta** Plate 1, fig. 25
Melanella (Melanella) retexta (Carpenter) Bartsch, 1917, Proc. U. S. Nat. Mus., v. 53, p. 317, pl. 38, fig. 1, figure of type.

556 **Leiostraca** ? **distorta** var. **yod**
Melanella (Balcis) yod (Carpenter), Bartsch, 1917, Proc. U.S. Nat. Mus., v. 53, p. 330, pl. 40, fig. 9, drawing of type.
Tablet 2027, 3 sp. in vial and drawing of type, B.M. sp.

557 **Cerithiopsis tuberculoides,** n.s.
Bartsch, 1911, Proc. U.S. Nat. Mus., v. 40, p. 336, pl. 37, fig. 7, drawing of type.
Tablet 2028, 2 sp., "with lip imperfect."

557b **Cerithiopsis** ? **tuberculoides** var. **albonodosa**
Bartsch, 1911, Proc. U.S. Nat. Mus., v..40, p. 337, pl. 37, fig. 3, drawing of type.
Tablet ? 2029, 1 sp.

558 **Cerithiopsis cerea,** n.s.
Bartsch, 1911, Proc. U.S. Nat. Mus., v. 40, p. 333, pl. 37, fig. 6, drawing of type.
Tablet 2030, —.

559 **Cerithiopsis pupiformis,** n.s.
Bartsch, 1911, Proc. U.S. Nat. Mus., v. 40, p. 337, pl. 38, figs. 1, 5, drawing of type.
Tablet 2031, 1 sp. in vial.

560 **Cerithiopsis Sorex**, n.s.
Bartsch, 1911, Proc. U.S. Nat. Mus., v. 40, p. 333, pl. 37, fig. 2, drawing of type.
Tablet 2032, 1 sp.

561 **Cerithiopsis convexa**, n.s.
Tablet 2033, —.

562 **Cerithiopsis decussata**, n.s.
Bittium decussatum (Carpenter), Bartsch, 1911, Proc. U.S. Nat. Mus., v. 40, p. 409, pl. 52, fig. 2, drawing of type.
Tablet 2034, —.

563 **Cerithiopsis assimilata** C. B. Adams
Tablet 2035, 2 sp., young and adult.

564 **Scalaria hexagona** Sowerby
Tablet 2036, —.

565 **Scalaria suprastriata**, n.s.
Tablet 2037, 1 sp.

566 **Scalaria** ————, sp. ind. (*a*)
Tablet 2038, "minute shell of four whirls." [whorls]

567 **Scalaria** ————, sp. ind. (*b*)
Tablet 2039, —.

568 **Scalaria raricostata**, n.s.
Tablet 2040, —.

569 **Cirsotrema funiculata**, ? n.s.
Tablet 2041, —.

570 **Natica maroccana** Chemnitz
Tablet 2042, —. 2043, 1 sp.—2044, 2 sp.—2045, 2 opercula —2046, 3 sp.—2047, —. 2048, 2 sp.—2049, 3 sp.—2050, 2 sp.

571 **Natica** ————, sp. ind.
Tablet 2051, —.

572 **Lunatia tenuilirata**, n.s.
Tablet 2052, —.

573 **Lunatia** ————, sp. ind. (*a*)
Tablet 2053, —.

574 **Lunatia** ———, sp. ind. (*b*)
Tablet 2054, 2 sp.

575 **Lunatia** ———, sp. ind. (*c*)
Tablet 2055, 2 sp.

576 **Polinices uber** Valenciennes
Tablet 2056, 3 sp.—2057, 2 sp.—2058, 4 sp., all white, umbilicus, open.—2059, 3 sp., all white, umbilicus open. —2060, 3 sp., white, umbilicus open.—2061, 3 sp.

577 **Lamellaria** ———, sp. ind. (*a*)
Tablet 2062, —.

578 ? **Lamellaria** ———, sp. ind. (*b*)
Tablet 2063, —.

[579 **Ficula ventricosa** Sowerby]

580 **Argobuccinum nodosum** Chemnitz
Tablet 2064, 1 sp.—2065, —. 2066, 1 sp.—2067, —. 2068, —. 2069, —. 2070, —. 2071, 1 sp. mended by animal after fracture.—2072, 1 sp.—Fourteen sp. loose, tablet number lost.

581 **Turbinella caestus** Broderip
Tablet 2073, —. 2074, —. 2075, 1 sp. with operculum. —2076, —. 2077, —. 2078, —. Three large specimens loose, tablet number lost.

582 **Lathirus ceratus** Gray
Tablet 2079, 1 sp.

583 **Leucozonia cingulata** Lamarck
Tablet 2080, 2 sp., labrum with long horn.—2081, 4 sp. and opercula.—2082, 3 sp., (1 with operculum) labrum with long horns, —2083, 3 sp.—2084, 3 sp. labrum with long horns. —2085, 3 sp.—2086, 2 sp., lip mended by animal after fracture. —2087, 1 sp.

584 **Fasciolaria princeps** Sowerby
Tablet 2088, 1 sp. epidermis and shell encrusted.—2089, —. 2090, —.

585 **Mitra lens** Mawe
Tablet 2091, 3 sp.—2092, 5 sp.—2093, 4 sp.—2094, 4 sp. —2095, 1 sp.—2096, 1 sp.—2097, —. 2098, 1 sp. and negative of photo of B.M. sp.

586 **Strigatella tristis** Broderip
Tablet 2100, 2 sp.—2101, 3 sp.—2102, 5 sp.—2103, 3 sp. —2104, 1 sp.—2105, 3 sp., "encrusted with coralline."—2106, 1 sp.

587 **Marginella minor** C. B. Adams Plate 1, figs. 16, 18
Tablet 2107, 8 sp. in vial and 2 drawings of 2 B.M. sp.

588 **Marginella polita,** n.s. Plate 1, fig. 17
Tablet 2108, 2 sp. in vial and drawing of B.M. sp.

589 **Marginella margaritula,** n.s. Plate 1, figs. 14, 15
Tablet 2109, 7 sp. in vial and drawings of large and small B.M. specimens.

590 **Oliva angulata** Lamarck
Tablet 2110, 1 broad sp.

591 **Oliva Melchersi** Menke
Tablet 2111, 1 sp.—2112, —. 2113, 1 sp.—2114, 1 sp. —2115, 1 sp.—2116, 1 sp.—2117, 1 sp.—2118, 1 sp.—2119, 1 sp.—2120, 1 sp., "zigzag lines separating."

592 **Oliva intertincta** ?, n.s.
Tablet 2121, 2 sp.

593 **Oliva ? venulata** Lamarck
Tablet 2122, 1 sp.—2123, 3 sp.—2124, 2 sp.—2125, 3 sp. —2126, 2 sp.—2127, 2 sp.—2128, 3 sp.—2129, 1 sp.—2130, 2 sp.—2131, 1 sp.—2132, 1 sp.—2133, 2 sp.—2134, 1 sp. —2135, 2 sp.—2136, 1 sp.

594 **Oliva Duclosi** Reeve
Tablet 237, 1 sp.

595 **Olivella undatella** Lamarck
Tablet 2138, 5 sp.—2139, 5 white sp.—2140, 5 sp.—2141, 5 sp.—2142, 5 sp.—2143, 2 white sp.—2144, 5 sp.—2145, 4 sp. and 1 gone.—2146, 5 sp.—2147, 4 sp.—2148, 5 sp., zigzag.—2149, 3 sp.—2150, 2 whitish sp.—2151, 5 sp.—2152, 4 sp.—2153, 5 sp.—2154, 5 sp.—2155, 5 sp.—2156, 2 sp.—2157, 5 sp.—2158, 5 sp.—2159, 5 sp.—2160, 5 sp.—2161, 5 sp.—2162, 5 sp.—2163, 5 sp.—2164, 4 sp.—2165, 5 sp.—2166, 5 sp.—2167, 5 sp. "Mended by animal after fracture." —2168, 5 sp., (1 dark, 3 light, 1 spotted).—2169, 5 sp.

596 **Olivella tergina** Duclos
Tablet 2170, 5 sp.—2171, 5 sp.—2172, 3 sp.—2173, 5 sp. —2174, 3 sp.—2175, 5 sp.—2176, 5 sp.—2177, 5 sp.—2178, 3 sp.—2179, 5 sp.—2180, 3 sp.—2181, 5 sp.—2182, 15 sp. —2183, 11 sp.—2184, 9 sp.

597 **Olivella anazora** Duclos
Tablet 2185, 1 sp.

598 **Olivella** ? **petiolita** var. **aureocincta**
Tablet 2186, 3 sp. and negative of photo of 8 sp.

599 **Olivella inconspicua** C. B. Adams Plate 1, fig. 23
Oliva inconspicua C. B. Adams, Carpenter, 1863, Proc. Zool. Soc. London, p. 342.
Tablet 2187, vial with 6 sp. and large drawing of B.M. sp.

600 **Olivella dama** Mawe
Tablet 2188, 1 sp.—2189, 3 sp.—2190, 3 sp.—2191, 3 sp. —2192, 3 sp.—2193, 2 sp.—2194, 3 sp.—2195, 3 sp.—2196, 3 sp.—2197, 5 sp.

601 **Olivella zonalis** Lamarck
Tablet 2198, vial containing 1 sp.

602 **Agaronia testacea** Lamarck
Tablet 2199, 3 sp.—2200, 3 sp.—2201, 3 sp.—2202, 2 sp. —2203, 2 sp.—2204, 1 sp.—2205, 1 sp. and negative of photograph of 1 sp.—2206, 1 sp.—2207, 3 sp.—2208, 3 sp. —2209, 3 sp.—2210, —. 2211, 1 sp. 2212, negative of photograph of B.M. sp.—2213, 3 sp.

603 **Purpura patula** Linnaeus
Tablet 2214, 6 sp. and 1 operculum.—2215, 4 large sp. —2216, 3 large sp.—2217, 2 sp.—2218, 1 large sp.—2219, 1 sp. "after hot acid, inside with light band."—2220, —.

604 **Purpura columellaris** Lamarck
Tablet 2221, 3 sp.—2222, 1 sp. and operculum.—2223, 5 sp.—2223*, 1 sp.—2224, 5 sp.—2225, 5 sp. aperture deformed, —2226, 2 sp.—2227, 3 sp.—2228, 1 sp.—2229, 2 opercula.

605 **Purpura muricata** Gray
Tablet 2230, 1 sp.—2231, 1 large sp.

606 **Purpura biserialis** Blainville

Tablet 2232, —. 2233, 8 sp.—2234, 7 sp., 3 opercula.—2235, 5 sp. and opercula.—2236, 3 sp., large to small.—2237, 4 sp. with faint knobs.—2238, 4 sp. and 1 separate operculum.—2239, —. 2240, 7 sp.—2241, 7 sp.—2242, 2 sp.—2243, 4 sp.—2244, 1 young sp.—2245, 11 sp., opercula.—2246, large opercula.—2247, —.

607 **Purpura triserialis** Blainville

Tablet 2248b, 2 sp. and separate opercula.—2248, 1 sp.—2249, 3 sp., "with two rows becoming obsolete."—2250, 1 sp.—2251, 1 operculum.

608 **Purpura triangularis** Blainville

Tablet 2252, —. 2253, 3 sp.—2254, 3 sp.—2255, 3 sp.—2256, 1 sp. with operculum and one separate operculum.

609 **Cuma kiosquiformis** Duclos

Tablet 2257, 2 sp.—2258, 3 sp.—2259, 1 sp.—2260, 1 large sp.—2261, 1 operculum.

610 **Cuma costata** Blainville

Tablet 2262, 3 sp.—2263, 3 sp.—2264, 3 sp.—2265, 4 sp.—2266, 3 sp.—2267, 3 sp.—2268, 3 sp.—2269, 6 sp.—2270, 4 sp.—2271, 2 sp.—2272, 6 sp.—2273, 4 sp.—2274, 1 sp.—2275, 1 sp. worn and encrusted.—2276, 3 sp. and 4 gone.—2277, 3 opercula.

611 **Rhizocheilus nux** Reeve

Tablet 2278, 1 sp.—2279, 1 sp.—2280, 1 sp.—2281, 4 sp.—2282, 3 sp.—2283, 3 sp.—2284, 2 sp. (opercula *in situ*) and 1 separate operculum.—2285, 1 sp.—2286, 4 sp. and negatives of photographs of 2 sp.

612 **Vitularia salebrosa** King

Tablet 2287, 1 sp.—2288, 3 sp.—2289, 2 sp.—2290, 3 sp. and 1 operculum.—2291, 3 sp.—2292, 2 sp. and opercula separate.—2293, 1 sp.—2294, 3 sp. (1 with operculum *in situ*).—2295, 2 sp., varices elevated.—2296, 3 sp. showing changes in color.—2297, 3 sp., "largest with *Gastrochaena truncata in situ* boring up the axis"; extremes of sculpture; one banded.—2298, 2 sp.—2299, 1 sp.—2300, 1 sp. and 1 operculum.—2301, —. 2302, —. 2303, 1 operculum gone.

613 **Nitidella cribraria**

Tablet 2304, —. 2305, 2 sp. and 1 gone.—2306, 5 sp., "decollated, varying in pattern."—2307, 1 sp. with operculum, separate operculum gone.

614 **Nitidella** ————, sp. ind.
Tablet 2308, —. 2309, —.

615 **Columbella major** Sowerby
Tablet 2310, 7 young sp.—2311, 5 sp.—2312, 5 sp.—2313, 5 sp.—2314, 5 sp.—2315, 5 sp.—2316, 4 sp. and 1 gone. —2317, 5 sp.—2318, 3 sp. and 2 gone.—2319, 5 sp.—2320, 4 sp.—2321, 3 sp.—2322, 4 sp.—2323, 3 sp.—2324, —. 2325, 3 sp.—2326, 5 sp.—2327, 5 sp.—2328, 11 opercula (3 gone). —2329, 3 sp.—2330, 6 sp.—2331, 6 sp.—2332, 6 sp. "nucleus almost central."—2333, sp. "of strange shapes through fracture."—2334, 3 sp.

616 **Columbella strombiformis** Lamarck
Tablet 2335, 2 sp. young and 1 gone.—2336, 3 sp.—2337, 5 sp.—2338, 3 sp.—2339, 3 sp.—2340, 1 sp. and 1 gone.—2341, 3 sp.

617 **Columbella fuscata** Sowerby
Tablet 2342, 7 sp., young.—2343, 3 sp.—2344, 5 sp.—2345, 5 sp.—2346, 3 sp.—2347, 2 sp.—2348, 2 sp.—2349, 3 sp.—2350, —. 2351, 2 sp.—2352, 3 sp., epidermis removed. —2353, 3 sp.—2354, 1 sp. with barnacle.—2355, 3 sp. mended by animal after fracture.—2356, 1 sp.

618 ? **Columbella cervinetta**, n.s.
Tablet 2360, —.

618b ? **Columbella cervinetta** var. **obsoleta**
Tablet 2361, vial with 1 sp., brown spots.

619 ? **Metula** ————, n.s. (*a*)
Tablet 2362, —.

620 ? **Metula** ————, n.s. (*b*)
Tablet 2363, glass present, sp. gone.

621 ? **Metula** ————, sp. ind. (*c*)
Tablet 2364, vial with 2 sp.

622 ? **Metula** ————, sp. ind. (*d*)
Tablet 2365, glass present, sp. gone.

623 **Nassa luteostoma** Broderip and Sowerby
Tablet 2366, —. 2367, 3 sp., lip forming.—2368, —. 2369,

5 sp.—2370, 7 sp.—2371, 3 sp.—2372, 3 sp.—2373, 5 sp.—2374, 2 sp. "after acid treatment."—2375, 1 sp. mended by animal after fracture.—2376, 3 sp.—2377, 2 sp.—2378, 10 opercula and 2 gone.—2379, vial with 2 opercula.—2380, vial with 3 opercula.—2381, vial containing 3 opercula with 2 or 3 prongs.—2382, —. 2383, vial containing 3 opercula.

624 **Nassa tegula** Reeve
Tablet 2384, 3 sp.—2385, 5 sp.—2386, 3 sp.—2387, 1 sp.—2388, 3 sp.—2389, 3 sp.—2390, —. 2391, 1 sp.

624b **Nassa ? tegula** var. **nodulifera** Philippi
Tablet 2393, 1 sp.

625 **Nassa (? pagodus,** var.**) acuta**
Tablet 2394, glass present, vial with sp. gone.

626 **Nassa** ————, sp. ind. (*a*)
Tablet 2395, —.

627 **Nassa** ————, sp. ind. (*b*)
Tablet 2396, glass present, vial with sp. gone.

628 **Nassa** ————, sp. ind. (*c*)
Tablet 2397, glass present, vial with sp. gone.

629 **Nassa** ————, sp. ind. (*d*)
Tablet 2398, vial containing 1 sp.

630 **Nassa** ————, sp. ind. (*e*)
Tablet 2399, vial containing 1 sp.

631 **Nassa ? gemmulosa** C. B. Adams
Tablet 2400, vial containing 1 sp.

632 **Nassa ? versicolor** C. B. Adams
Tablet 2401, vial containing 3 sp.

633 **Nassa crebristriata,** n.s.
Tablet 2402, negative of photo of type, B.M. sp.

634 **Nassa** ————, sp. ind. (*f*)
Tablet 2403, —.

635 **Nassa** ————, sp. ind. (*g*)
Tablet 2404, —.

636 **Nassa** ————, sp. ind. (*h*)
Tablet 2405, vial containing 2 sp.

637 **Nassa** ———, sp. ind. (*i*)
Tablet 2406, —.
Tablet 2407.

638 **Pyrula patula** Broderip and Sowerby
Tablet 2408, 4 sp. young.—2409, 3 adolescent sp.; first smooth, 2d "brownish black" with few spines, 3d tuberculate. —2410, 1 large smooth sp.—2411, 1 sp. "largest," with epidermis.

639 **Fusus pallidus** Broderip and Sowerby
Tablet 2412, 2 sp., young and adult.

640 **Fusus tumens,** n.s.
Tablet 2413, —.

641 **Fusus apertus,** n.s.
Tablet 2414, 1 sp.

642 ? **Fusus** ———, sp. ind. (*a*)
Tablet 2415, —.

643 ? **Fusus** ———, sp. ind. (*b*)
Tablet 2416, —.

644 ? **Cominella** ———, sp. ind.
Tablet 2417, —.

645 **Anachis scalarina** Sowerby
Tablet 2418, 1 sp. and negative of photos of 2 B.M. sp.

646 **Anachis costellata** Broderip and Sowerby
Tablet 2419, 3 sp.—2420, 3 sp.—2421, 3 sp.

646b **Anachis** (? **costellata** var.) **pachyderma**
Tablet 2422, —. 2423, 1 sp., operculum *in situ*.

646c **Anachis** ———, sp. ind.
Tablet 2424, —.

647 **Anachis coronata** Sowerby
Tablet 2425, 1 sp., negative of photos of 4 B.M. sp.

648 **Anachis ? fulva** Sowerby
Tablet 2426, —.

649 **Anachis nigrofusca,** n.s.
Tablet 2427 [numbered 2429 by error in B.M. Cat.], 1 sp.

650 **Anachis serrata,** n.s.
Tablet 2428, vial containing 4 sp.

651 **Anachis pygmaea** Sowerby
Tablet 2429, vial containing 6 sp.—2429*, vial containing 3 sp.

652 **Anachis Gaskoini,** n.s. = **A. taeniata** (Philippi), Carpenter, 1863.
Tablet 2430, —.

653 **Anachis rufotincta,** n.s.
Tablet 2431, 3 sp.

654 **Anachis albonodosa,** n.s.
Tablet 2432, 1 sp. in vial.

655 ? **Anachis** ———, sp. ind. (*a*)
Tablet 2433, 1 sp. in vial.

656 ? **Anachis** ———, sp. ind. (*b*)
Tablet 2434, —. 2435, —. [One specimen listed by Carpenter but no representative found.]

657 **Strombina maculosa** Sowerby
Tablet 2436, 1 sp.

658 ? **Strombina** ———, sp. ind.
Tablet 2437, —.

659 **Pisania insignis** Reeve
Tablet 2438, —. 2439, 7 sp.—2440, 5 sp.—2441, 5 sp. (elevated) and 2 opercula.—2442, —. 2443, were 5 sp., mixed now with other loose specimens.—2444, 5 sp.—2445, —. [2446, omitted].—2447, 6 sp.—2448, —. 2449, 6 sp. (several gone).—2450, 8 opercula.—Eighteen loose specimens can not be identified as to tablet numbers.

660 **Pisania** (? **pagodus,** var.) **aequilirata**
Tablet 2451, —.

661 **Pisania gemmata** Reeve
Tablet 2452, 3 sp.—2453, 4 sp.—2454, 5 sp. and 1 separate operculum.—2455, 3 sp.—2456, 3 sp.—2457, 3 sp.—2458, 3 sp.—2459, 7 opercula.—2460, 4 opercula. [Eighteen loose specimens, glass broken, tablet number unidentifiable.]

662 **Pisania sanguinolenta** Duclos

Tablet 2461, 2 sp.—2462, 3 sp.—2463, 3 sp. with encrusted Bryozoa.—2464, 3 opercula.

663 **Pisania ringens** Reeve

Tablet 2465, 1 sp.

664 **Murex plicatus** Sowerby

Tablet 2466, —.

665 **Murex ? recurvirostris, var. lividus**

Tablet 2467, 5 sp.—2468, 1 sp.—2469, —. 2470, 1 sp. —2471, —. 2472, —. 2473, 4 sp.—2474, —. 2475, —. 2476, —. 2477, —. 2478, 1 sp., and 11 opercula encrusted with worn tubes.—2479, —. 2480, 4 opercula. [Two loose sp., glass broken, tablet number destroyed.]

666 **Phyllonotus nigritus** Meuschen

Tablet 2481, 1 sp.—2482, 1 young sp. "with 6 varices." —2483, 2 sp.—2484, —. 2485, —. 2486, 1 sp.—2487, —. 2488, —. 2489, 1 sp. with 7 varices.—2490, —. 2491, —. 2492, 1 sp. with 9 varices.—2493, 1 sp. (broken).—2494, 1 sp., 9 varices.—2495, 1 sp. with opercula, 10 varices.—2496, 1 large sp. 11 varices.—[?] 2497, 1 sp. (largest), 11 or 12 varices. 2498, —. 2499, —.

667 **Phyllonotus nitidus** Broderip

Tablet 2500, —.

668 **Phyllonotus brassica** Lamarck

Tablet 2501a, uncleaned specimen with operculum.—2501b, cleaned sp.—2502, —.

669 **Phyllonotus bicolor**

Tablet 2503, 1 sp.

670 **Phyllonotus reguis** Swainson

Tablet 2504, 2 sp. "not cleaned."

671 **Phyllonotus princeps** Broderip

Tablet 2505, 1 sp. much encrusted.—2506, 1 sp. much encrusted.

672 **Muricidea ? lappa** Broderip

Tablet 2507, —. [One sp. listed by Carpenter in 1860, no representative in collection.]

673 **Muricidea dubia** Swainson
Tablet 2508-9, 1 sp.

674 **Muricidea ? erinaceoides** var. **indentata**
Tablet 2510, —. [One sp. listed by Carpenter, 1860, no representative in collection.]

675 **Murex** ———, sp. ind.
Tablet 2511, —.

676 **Muricidea pauxillus** A. Adams
Tablet 2512, 3 sp.—2513, 2 sp.—2513*, vial containing 1 sp.—2514, 2 sp.
Tablet 2515, vial containing 3 opercula.

680 ? **Naranio scobina,** n.s.
Tablet 2516, vial containing 3 sp.

681 ? **Mya** ———, sp. ind.
Tablet 2517, —.

682 ? **Corbula** ———, sp. ind. (*b*)
Tablet 2518, —.

683 **Sphaenia** ———, sp. ind.
Tablet 2519, —.

684 **Sphaenia** ———, sp. ind.
Tablet 2520, —.

685 **Tyleria fragilis** H. and A. Adams
[Footnote p. 531, B.M. Cat.]

693 ***Lyonsia** ———, sp. ind.
[Sequence of Nos. out of order, see footnote p. 530, B.M. Cat.]
Tablet 2538, —.

686 ***Tellina,** sp. ind. (*c*)
Tablet 2521, —.

687 **Cardium rotundatum,** n.s.
Tablet 2522, vial containing 1 valve.

688 **Lasea** ———, sp. ind.
Tablet 2523, —.

694 ? **Montacuta chalcedonica,** n.s.
Tablet 2529, —.

689 **Arca** ———, sp. ind. (*b*)
Tablet 2524, —.

690 **Pecten** ———, sp. ind. (*a*)
Tablet 2525, 1 sp.

691 **Pecten** ———, sp. ind. (*b*)
Tablet 2526, 2 fragments.

692 **Smaragdinella thecaphora** (Nutt.), n.s.
Tablet 2527, —.

The following numbers are not recorded in the B.M. Catalogue but are given in the catalog of the specimens deposited in the collections at Albany (see 13th Ann. Rep't New York Cab., 1860, p. 36).

695 ? **Lepton obtusum**
Tablet 2530, vial containing 2 valves.

696 **Pectunculus** ———.
P., sp. ind., Carpenter, 1865, Proc. Zool. Soc. London, p. 270.
Tablet 2531, vial containing 1 sp.

697 **Cylichna carpenteri**
Tablet ———.

698 **Scissurella rimuloides,** n.s. (1865) Plate 1, figs. 20-22
Carpenter, 1860, 13th Ann. Rep't New York State Cab., p. 36, listed as *remuloides;* 1865, Proc. Zool. Soc. London, p. 271, described.

Tablet 2532, 3 pencil drawings of type B.M. sp.

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EXPLANATION OF PLATE 1

FIGURE PAGE

1 *Tornatina carinata* Carpenter 30
No. 223. Drawing by Carpenter of syntype in the B.M.

2 *Obeliscus ? conicus, jun.* (C. B. Adams), Carpenter 53
No. 486. Drawing by Carpenter of specimen in the B.M.

3 *Orthalicus ? Mexicanus* (Lamarck), Carpenter 31
No. 234. Drawing by Carpenter of the specimen referred to in the Mazatlan Cat., p. 178.

4 *Haminea cymbiformis* Carpenter 30
No. 229. Drawing by Carpenter of the holotype in the B.M.

5 *Torinia ? granosa* (Valenciennes), Carpenter 53
No. 485. Drawing by Carpenter of specimen in the B.M.

6 *Odostomia* ————, sp. ind. 54
No. 488. Drawing by Carpenter of specimen in the B.M.

7 *Aclis tumens* Carpenter 60
No. 546. Drawing by Carpenter of the holotype in the B.M.

8 *Aclis fusiformis* Carpenter 60
No. 545. Drawing by Carpenter of a syntype in the B.M.

9 *Leisotraca producta* Carpenter, 1865 60
No. 551. Mazatlan Cat. *L. ? solitaria.* Drawing of the holotype in the B.M.

10 *Leiostraca solitaria* C. B. Adams, Carpenter, 1863 61
No. 552. *Leiostraca* ————, sp. ind. (*a*). Drawing by Carpenter of specimen in the B.M.

11 *Auriculina* ————, sp. ind. (*b*) 54
No. 495. Drawing by Carpenter of specimen in the B.M.

12 *Leiostraca involuta* Carpenter, 1865 60
No. 550. Drawing by Carpenter of the holotype in the B.M.

13 *Eulima* ————, sp. ind. (*b*) 60
No. 549. Drawing by Carpenter of restored specimen in the B.M.

14, 15 *Marginella margaritula* Carpenter 64
No. 589. Drawing of syntypes in the B.M.

16 *Marginella minor* C. B. Adams, Carpenter 64
No. 587. Drawing by Carpenter in the B.M. Figure is on the same tablet with fig. 18.

17 *Marginella polita* Carpenter 64
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18 *Marginella minor* C. B. Adams, Carpenter 64
No. 587 with fig. 16.

19 *Caecum undatum* Carpenter 44
No. 371. Group of syntypes in the B.M. representing ten stages of development. Also figured by Carpenter, 1857.

20–22 *Scissurella rimuloides* Carpenter, 1865 73
No. 698 (1865). Drawing by Carpenter of the holotype in the B.M.

23 *Olivella inconspicua* (C. B. Adams), Carpenter 65
No. 599. Drawing by Carpenter of specimen in the B.M.

24 *Leiostraca linearis* Carpenter 61
No. 554. Drawing by Carpenter of the holotype in the B.M.

25 *Leiostraca ? iota* var. *retexta* Carpenter 61
No. 555. Drawing by Carpenter of the holotype in the B.M.

All the drawings are in the Mazatlan Collection in the New York State Museum. Size of enlargement is not given with the drawings. See the Mazatlan Catalogue for dimensions of specimens.

INDEX

The Mining and Quarry Industries of New York State, 1937 to 1948

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CONTENTS

MINING AND QUARRY INDUSTRIES 1937 TO 1948

INTRODUCTION

The present report on the mining and quarry industries of New York is one of a series that dates back to 1904 and, like its predecessors, contains not only chapters on the various mineral industries, but also numerous statistical tables recording quantity and value of the various minerals produced. In the statistical summaries herewith set forth for the years 1937 to 1948 inclusive, it will be seen that the value of mineral production for 1948 is $158,583,000. The 1948 value marks an all-time high, and while there was an increase in price for most minerals in that year, there was also an important increase in quantity for a number of outstanding minerals.

In the present review the annual mineral production is shown to have exceeded one hundred million dollars in 1942, 1946, 1947 and 1948, a record approached in only one period previously—during the prosperous years of 1926-30 inclusive. In each of these five years mineral production reached a total in excess of one hundred million dollars, the highest being in 1926 when the value ran to $113,249,609—a record production until that of 1947. The depression of the early thirties had a disastrous effect on the mining industry, not only in New York, but elsewhere as well. In the period from 1930 to the end of 1933, production was curtailed about 60 per cent with a record low in the latter year of $43,503,926. After 1933 production gained rapidly, and the 1937 value was nearly double that of 1933.

The rank of New York as a mineral-producing state has varied considerably during the past two or three decades. In 1929 New York held 14th place among the states and, curiously enough, even with reduced production, during the depression years, the State moved up in the list of mineral producers. In 1930 it stood 12th; in 1931 it ranked 8th; and in 1932 it was 11th. More recently, discoveries and increased production of petroleum in other states have been a factor in placing New York 18th in the annual value of mineral products (1947). In certain fields of the mineral industry, however, such as the production of gypsum, emery, ground talc, iron ore, ilmenite, stone, salt and sand and gravel, New York holds a leading place and for some of the minerals is actually ahead of all other states.

As taken into account in this report, the quantities and values of rocks, minerals and ores, some thirty in number, represent, with few exceptions, the products in their original form as they come from the local mines and quarries without elaboration or manufacture except in so far as may have been necessary to put them in marketable condition. For example, iron ore is included in their number, but such secondary products as iron and steel are not, even though made of local ores. No account is given to other secondary materials such as ferro-alloys, aluminum, coke, alkali products of salt, artificial graphite and other substances made from crude ores and minerals, which in combined value far outrank the totals herewith recorded for the basic materials of the mines and quarries.

For the purposes of this report, statistics are collected almost exclusively by a cooperative arrangement with the United States Bureau of Mines. The number of individual mineral producers canvassed annually is in excess of 1000 and acknowledgment is due them for their interest and support. In the reporting of recent Adirondack mining developments the writers desire to express special appreciation to the officials of the operating companies for their friendly cooperation and assistance.

Cement. In 1948 the shipments of 12,299,226 barrels of portland cement, valued at $26,071,417, marked an all-time record both as to quantity and value of product, its value exceeding that of any other mineral produced in the State during the year.

The natural cement industry, which until 1906 exceeded portland cement in annual production but thereafter rapidly declined in importance, has experienced a moderate revival in recent years.

Clay products. There has been no detailed canvass of clay products in recent years. Pottery last appears in our tables for 1938. Statistics on value of other clay products, mostly brick, have been supplied by the Bureau of the Census. In the period covered by this report, the values run from less than two million in 1942 to more than 13 million in 1948.

Emery. The emery mines in the Peekskill district supply the entire output of emery in the United States. Mining operations are carried on by one or two firms which have given their permission to publish statistics on production. In 1948 this amounted to 5405 tons, valued at $69,408.

Garnet. The garnet mine at North River has been active for many years and continues to supply the bulk of the abrasive garnet produced in the United States.

Gypsum. The annual production of crude gypsum has varied considerably in the period covered by this report. The low production was in 1945, with an output of 557,902 tons; the high production of 1,228,358 tons was in 1948. In previous issues of mining and quarry reports the value of sales of gypsum has been based on the quantity sold as lump or ground and that sold calcined as wall plaster and other gypsum building materials. Beginning with 1937 the value of gypsum is based on the estimated value of crude gypsum at the mine. Owing to this change, the state total of mineral production is reduced by several million dollars. In 1936 the value of sales of crude and calcined gypsum from a mine output of 609,204 tons was $6,585,277; in 1937 the estimated value of 700,357 tons of crude gypsum mined was $1,107,175.

For many years New York was the leading state in the production of crude gypsum, but since 1945 the Michigan production has exceeded that of New York.

Iron ore. Since 1938 outstanding history has been made in the iron-mining industry of New York by the entrance into the Adirondack region of several of the major ore-producing companies—the Republic Steel Corporation, Jones and Laughlin Ore Company, Hanna Ore Company and the National Lead Company. In 1938 shipments consisted of 435,761 long tons of iron ore valued at $1,841,455. The 1948 shipments totaled 2,932,442 long tons, valued at $24,384,648.

Natural gas. The discovery of natural gas in the Oriskany sandstone in 1930 increased production from six or seven billion cubic feet annually in previous years to an all-time record production in 1938 of 39.4 billion cubic feet, valued at $19,419,000. Continued search for new supplies, although successful to a certain extent, has not been able to prevent a gradual decline in annual production, which in 1948 amounted to 4.7 billion cubic feet, valued at $3,482,000.

Petroleum. Through the use of improved methods for increasing the production of oil, mostly by water flooding, the output has been maintained at a fairly high level during recent years. The 1937 production of 5,478,000 barrels of petroleum was the highest since the flush production of the early eighties. The high price of oil gave a record value of $22,975,000 for 4,621,000 barrels produced in 1948.

Salt. During recent years the production of salt has shown a substantial increase—an annual total of over 20 million barrels being first attained in 1943. The 1948 output of 21,898,793 barrels, valued at $13,056,542, surpasses that of any other year.

The chemical industries are large users of salt and much of the output does not enter the market in its original form, but is converted into sodium products. In value of salt produced, New York ranks second only to Michigan.

Sand and gravel. There was a sharp falling off in the production of sand and gravel for the three years 1943 to 1945, when annual production was less than 50 per cent of the preceding three years. From an output of less than eight million tons in 1945, production increased to an all-time record in 1948 of 16,369,303 tons valued at $13,382,370.

Slate. There has been an important increase in the value of slate produced since 1937. In that year the value of slate produced was $365,024. In each of the past three years the value of the annual output has exceeded one million dollars, the highest being $1,575,252 in 1947. Only once before, in 1928, has the value of slate exceeded one million dollars, when it reached $1,052,368. The growth of the slate industry during the past 30 years has been due to the manufacture of slate granules for roofing, which was started in 1917.

Stone. The total value of the quarry products of granite, limestone, marble, sandstone and trap, but exclusive of the value of limestone used for cement-making and lime, was $17,261,486 in 1948. This value was exceeded in the four-year period 1927 to 1930, the 1929 value being $18,840,374. The value of limestone greatly exceeds that of all other types of stone combined. The total tonnage of stone in 1948 amounted to 12,687,970 tons. The 1947 output was 11,197,990 tons valued at $14,992,064.

Talc. New York continues to be the leading state in the production of talc. The 1948 production amounted to 119,716 tons, valued at $2,613,935.

Titanium dioxide (ilmenite). Within the past ten years one of the outstanding developments in the Adirondack mining industry was the reopening of the old mine in the large titaniferous magnetite deposits at Lake Sanford. Curiously enough, this mine, which in former years had been worked unsuccessfully for its iron content, has now become the most important source of titanium concentrates (ilmenite) in the United States. Since the start of operations in 1942 production has grown steadily, and in 1948 the mine production amounted to 284,000 short tons of titanium concentrates. This mine is also the source of important quantities of iron ore.

Zinc. Zinc mining in St Lawrence county has been continuous since mining operations started in 1915. During recent years three mines have been in operation and one of these, the Balmat, is the third largest zinc-producing mine in the United States. In addition to zinc, this mine produces a substantial amount of pyrite, lead and some silver. For the period covered by this report, high production of zinc was in 1943 with an output of 46,000 tons. The 1948 production was 34,566 tons, valued at $9,194,556.

Other materials. Among the miscellaneous minerals produced in the State during the period covered by the present report are several which are marketed in some cases by one, in others, by two firms, from whom permission to publish production has not been obtained. In such instances, where values are given, they are for 1948 unless otherwise stated. The miscellaneous minerals include: slip clay; diatomaceous earth; feldspar and quartz; lead (from zinc mine, 1231 short tons, value $440,698); millstones (production now very small); natural gasoline (11,000 gallons, value $1000); peat (production in moderate amounts in a few sections of the State); pyrite (in 1946, fourth among states in value of production); silver (from zinc mine, 18,788 ounces, value $17,004).

Graphite. New York was once the leading producer of natural graphite but the last mine ceased operation in 1941.

Magnesium. A plant for the manufacture of magnesium from dolomite was put in operation in 1943. In 1944, the last year of operation, the production was 1380 short tons of magnesium, valued at $565,800.

Wollastonite. Since 1943 New York has been a producer of wollastonite. The mineral is obtained from a mine or quarry in Essex county. This mine is the only one producing wollastonite in the United States. The annual production is small and in 1948 amounted to 75 tons valued at $1,500.

Annual mineral production in New York, 1937-48

YEAR	VALUE
1937	$84 173 532
1938	77 895 931
1939	78 409 560
1940	76 119 505
1941	91 582 704
1942	108 389 930
1943	88 416 000
1944	87 638 131
1945	91 967 539
1946	105 681 336
1947	133 083 988
1948	158 583 000

Mineral production in New York in 1948

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	12 299 226	$26 071 417
Natural cement	Barrels	....	*a*
Clay products other than pottery and refractories	....	....	13 270 000
Pottery	....	....	*b*
Crude clay	Short tons	....	*a*
Diatomaceous earth	Short tons	....	*d*
Emery	Short tons	5 405	69 408
Feldspar, crude	Long tons	....	*a*
Garnet	Short tons	....	*a*
Gypsum, crude	Short tons	1 228 358	3 294 973
Iron ore	Long tons	2 932 442	24 384 648
Lead	Short tons	1 231	440 698
Millstones	....	....	*a*
Metallic paint	Short tons	....	*c*
Mineral waters	Gallons	....	*b*
Natural gas	1000 cu. ft.	4 705 000	3 482 000
Natural gasoline	Gallons	11 000	1 000
Peat	Short tons	....	*d*
Petroleum	Barrels	4 621 000	22 975 000
Pyrite	Long tons	....	*a*
Salt	Barrels	21 898 793	13 056 542
Molding sand	Short tons	470 275	961 335
Other sand and gravel	Short tons	15 899 028	12 421 035
Silver	Ounces (troy)	18 788	17 004
Slate	Short tons	....	1 532 880
Granite	Short tons	7 780	106 344
Limestone *e*	Short tons	11 140 160	14 368 124
Lime	Short tons	....	*a*
Marble	Short tons	....	*a*
Miscellaneous stone	Short tons	....	*a*
Sandstone	Short tons	79 500	427 508
Trap	Short tons	1 259 200	1 964 215
Talc	Short tons	119 716	2 613 935
Titanium concentrates (Ilmenite)	Short tons	284 000	*a*
Wollastonite	Short tons	75	1 500
Zinc ore	Short tons	154 361	*f*
Zinc-lead ore	Short tons	309 688	*f*
Zinc	Short tons	34 566	9 194 556
Other materials	....	....	7 927 878
Total value	....	....	$158 583 000

a Included under other materials.
b No canvass in 1948.
c Included with iron ore.
d No report.
e Exclusive of limestone used for lime and cement making.
f Not valued as ore; value of recoverable content included with the metals.

Mineral production in New York in 1947

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	11 592 821	$21 060 957
Natural cement	Barrels	....	*a*
Clay products, other than pottery and refractories	....	....	9 021 000
Pottery	....	....	*b*
Crude clay	Short tons	....	*a*
Diatomaceous earth	Short tons	....	*c*
Emery	Short tons	5 798	66 927
Feldspar, crude	Long tons	....	*a*
Garnet	Short tons	....	*a*
Gypsum, crude	Short tons	949 375	2 613 094
Iron ore	Long tons	2 513 555	19 673 363
Lead	Short tons	1 496	430 848
Marl (calcareous)	Short tons	300	3 000
Metallic paint	Short tons	....	*e*
Millstones	....	....	*a*
Mineral waters	Gallons	....	*b*
Magnesium	Short tons	....	*c*
Natural gas	1000 cu. ft.	4 776 000	3 535 000
Natural gasoline	Gallons	10 000	1 000
Peat	Short tons	....	*a*
Petroleum	Barrels	4 762 000	20 050 000
Pyrite	Long tons	....	*a*
Salt	Barrels	20 878 736	11 875 485
Molding sand	Short tons	503 091	1 009 294
Other sand and gravel	Short tons	13 317 105	9 896 930
Slate	Short tons	....	1 575 252
Granite	Short tons	57 990	228 951
Limestone *f*	Short tons	9 908 880	12 676 404
Lime	Short tons	....	*a*
Marble	Short tons	24 070	187 632
Miscellaneous stone	Short tons	201 250	164 768
Sandstone	Short tons	80 820	371 385
Trap	Short tons	924 980	1 362 924
Talc	Short tons	....	*a*
Titanium concentrates (Ilmenite)	Short tons	252 000	*a*
Wollastonite	Short tons	....	1 600
Zinc ore	Short tons	114 995	*d*
Zinc-lead ore	Short tons	322 898	*d*
Zinc	Short tons	34 116	8 256 072
Silver	Ounces (troy)	22 409	20 280
Other materials	....	....	9 001 822
Total value	....	....	$133 083 988

a Included under other materials.
b No canvass in 1947.
c No production in 1947.
d Not valued as ore; value of recoverable metal content included with metals.
e Included with iron ore.
f Exclusive of limestone used for lime and cement making.

Mineral production in New York in 1946

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	10 514 431	$17 547 319
Natural cement	Barrels	....	*a*
Clay products, other than pottery and refractories	....	....	7 289 000
Pottery	....	....	*b*
Crude clay	Short tons	....	33 939
Diatomaceous earth	Short tons	....	*a*
Emery	Short tons	6 188	62 099
Feldspar, crude	Long tons	....	*a*
Garnet	Short tons	....	*a*
Gypsum, crude	Short tons	814 999	1 961 157
Iron ore	Long tons	960 098	7 819 639
Metallic paint	Short tons	....	*g*
Lead	Short tons	1 073	233 914
Millstones	....	....	*a*
Mineral waters	Gallons	....	*b*
Magnesium	Short tons	....	*d*
Natural gas	1000 cu. ft.	5 084 000	3 461 000
Natural gasoline	Gallons	8 000	*a*
Peat	Short tons	....	*f*
Petroleum	Barrels	4 863 000	18 630 000
Pyrite	Long tons	....	*a*
Salt	Barrels	20 098 443	10 153 274
Molding sand	Short tons	495 099	900 274
Other sand and gravel	Short tons	11 584 150	8 006 826
Slate	Short tons	....	1 160 404
Granite	Short tons	10 470	82 500
Limestone *e*	Short tons	8 759 700	10 154 406
Lime	Short tons	....	*a*
Marble	Short tons	....	*a*
Miscellaneous stone	Short tons	81 540	51 708
Sandstone	Short tons	116 960	371 452
Trap	Short tons	948 540	1 267 244
Talc	Short tons	....	*a*
Titanium concentrates (Ilmenite)	Short tons	209 009	*a*
Wollastonite	Short tons	....	*a*
Zinc ore	Short tons	130 069	*c*
Zinc-lead ore	Short tons	262 197	*c*
Zinc	Short tons	32 515	7 933 660
Silver	Ounces (troy)	15 786	12 755
Other materials	....	....	8 548 766
Total value	....	....	$105 681 336

a Included under other materials.
b No canvass in 1946.
c Not valued as ore; value of recoverable metal content included with metals.
d No production.
e Exclusive of limestone used for lime and cement.
f Figures not available.
g Included with iron ore.

Mineral production in New York in 1945

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	5 578 906	$9 009 454
Natural cement	Barrels	....	*a*
Clay products, other than pottery and refractories	....	....	2 376 670
Pottery	....	....	*b*
Crude clay	Short tons....	....	34 238
Diatomaceous earth	Short tons	....	*a*
Emery	Short tons	7 856	75 977
Feldspar, crude	Long tons	....	*a*
Garnet	Short tons	....	*a*
Gypsum, crude	Short tons	557 902	1 262 989
Iron ore	Long tons	1 965 655	15 136 120
Metallic paint	Short tons	....	*f*
Lead	Short tons	862	148 264
Millstones	....	....	3 577
Mineral waters	Gallons	....	*b*
Magnesium	Short tons	....	*d*
Natural gas	1000 cu. ft.	9 210 000	5 919 000
Natural gasoline	Gallons	8 000	*a*
Peat	Short tons	....	*a*
Petroleum	Barrels	4 648 000	17 470 000
Pyrite	Long tons	....	*a*
Salt	Barrels	20 444 457	10 327 013
Molding sand	Short tons	405 208	664 602
Other sand and gravel	Short tons	7 072 420	4 385 303
Slate	Short tons	....	*a*
Granite	Short tons	....	44 246
Limestone *e*	Short tons	6 822 240	7 624 756
Lime	Short tons	....	*a*
Marble	Short tons	....	*a*
Miscellaneous stone	Short tons	....	89 552
Sandstone	Short tons	....	229 078
Trap	Short tons	....	1 033 312
Talc	Short tons	....	*a*
Titanium concentrates (Ilmenite)	Short tons	240 090	*a*
Wollastonite	Short tons	....	*a*
Zinc ore	Short tons	97 040	*c*
Zinc-lead ore	Short tons	228 062	*c*
Zinc	Short tons	24 978	5 744 940
Silver	Ounces (troy)	14 271	10 148
Other materials	....	....	10 378 300
Total value	....	....	$91 967 539

a Included under other materials.
b No canvass in 1945.
c Not valued as ore; value of recoverable metal content included with metals.
d No production.
e Exclusive of limestone used for lime and cement.
f Included with iron ore.

Mineral production in New York in 1944

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	4 411 695	$6 839 676
Natural cement	Barrels	....	*a*
Clay products, other than pottery and refractories	....	....	1 500 000
Pottery	....	....	*b*
Crude clay	Short tons	....	*a*
Diatomaceous earth	Short tons	....	*a*
Emery	Short tons	6 940	64 858
Feldspar, crude	Long tons	....	*a*
Garnet	Short tons	....	*a*
Gypsum, crude	Short tons	594 067	1 128 821
Iron ore	Long tons	1 886 464	15 312 350
Metallic paint	Short tons	....	*e*
Lead	Short tons	1 644	263 040
Millstones	....	....	*a*
Mineral waters	Gallons	....	*b*
Magnesium	Short tons	1 380	565 800
Natural gas	1000 cu. ft.	7 052 000	5 164 000
Natural gasoline	Gallons	12 000	1 000
Peat	Short tons	....	*a*
Petroleum	Barrels	4 697 000	15 640 000
Pyrite	Long tons	....	*a*
Salt	Barrels	20 897 679	9 899 580
Molding sand	Short tons	633 110	745 917
Other sand and gravel	Short tons	6 416 473	3 562 473
Slate	Short tons	8 040	791 093
Granite	Short tons	....	*a*
Limestone *d*	Short tons	6 338 740	6 577 696
Lime	Short tons	193 395	1 410 956
Marble	Short tons	....	*a*
Miscellaneous stone	Short tons	....	*a*
Sandstone	Short tons	....	*a*
Trap	Short tons	....	*a*
Talc	Short tons	....	*a*
Titanium concentrates (Ilmenite)	Short tons	216 253	*a*
Wollastonite	Short tons	....	*a*
Zinc ore	Short tons	120 106	*c*
Zinc-lead ore	Short tons	303 451	*c*
Zinc	Short tons	35 541	8 103 348
Silver	Ounces (troy)	25 238	17 947
Other materials	....	....	10 049 576
Total value	....	....	$87 638 131

a Included under other materials.
b No canvass in 1944.
c Not valued as ore; value of recoverable metal content included with metals.
d Exclusive of limestone used for lime, cement and magnesium.
e Included with iron ore.

Mineral production in New York in 1943

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	5 914 660	$8 765 665
Natural cement	Barrels	....	*a*
Clay products, other than pottery and refractories *b*	....	....	3 000 000
Pottery	....	....	*c*
Crude clay	Short tons	....	*a*
Diatomaceous earth	Short tons	....	*a*
Emery	Short tons	6 666	63 195
Feldspar and quartz	Short tons	....	*a*
Garnet	Short tons	....	*a*
Gypsum, crude	Short tons	713 961	1 229 796
Iron ore	Long tons	1 363 202	11 892 756
Lead	Short tons	2 355	353 250
Marl	Short tons	....	*a*
Millstones	....	....	*a*
Metallic paint	Short tons	....	*e*
Mineral waters	Gallons	....	*c*
Natural gas	1000 cu. ft.	8 062 000	5 994 000
Natural gasoline	Gallons	14 000	1 000
Peat	Short tons	....	*a*
Petroleum	Barrels	5 059 000	15 230 000
Pyrite	Long tons	62 907	227 723
Salt	Barrels	20 902 771	9 328 672
Molding sand	Short tons	432 777	734 689
Other sand and gravel	Short tons	9 542 206	4 775 861
Sand-lime brick	....	....	*c*
Slate	....	....	613 566
Silver	Ounces (troy)	38 004	27 025
Granite	Short tons	225 240	295 068
Limestone *d*	Short tons	6 907 830	6 652 586
Lime	Short tons	121 890	976 692
Magnesium	Short tons	....	*a*
Marble	Short tons	20 410	133 805
Miscellaneous stone	Short tons	181 180	100 443
Sandstone	Short tons	163 050	334 634
Trap	Short tons	1 163 260	1 400 628
Talc	Short tons	136 291	2 003 080
Titanium concentrates	Short tons	165 198	*a*
Wollastonite	Short tons	....	*a*
Zinc	Short tons	46 000	9 936 000
Other materials	....	....	4 599 869
Total value	....	....	$88 670 003

a Included under other materials.
b Figures from U. S. Bureau of Mines.
c No canvass in 1943.
d Exclusive of limestone or dolomite used for lime, cement and magnesium.
e Included with iron ore.

Mineral production in New York in 1942

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	11 027 118	$16 030 995
Natural cement	Barrels	....	*a*
Building brick	Thousands	152 993	1 935 596
Pottery	....	....	6 590 629
Clay products, other than pottery and refractories	....	....	2 565 369
Crude clay	Short tons	....	*a*
Diatomaceous earth	Short tons	....	*a*
Emery	Short tons	5 277	49 413
Feldspar and quartz	Short tons	....	*a*
Garnet	Short tons	....	*a*
Gypsum, crude	Short tons	1 012 987	1 605 530
Iron ore	Long tons	1 218 618	10 941 428
Lead	Short tons	2 434	326 156
Magnesium	....	....	*a*
Marl	Short tons	....	*a*
Millstones	....	....	*a*
Metallic paint	Short tons	....	*d*
Mineral waters	Gallons	....	*b*
Natural gas	1000 cu. ft.	8 718 000	6 498 000
Natural gasoline	Gallons	15 000	1 000
Peat	Short tons	9 000	41 000
Petroleum	Barrels	5 421 000	16 000 000
Pyrite	Long tons	68 826	250 527
Salt	Barrels	19 447 643	8 158 147
Molding sand	Short tons	529 809	851 575
Other sand and gravel	Short tons	15 755 558	10 989 670
Sand-lime brick	Thousands	....	*b*
Slate	....	....	659 590
Silver	Ounces (troy)	40 012	28 453
Granite	Short tons	275 690	263 610
Limestone *c*	Short tons	9 573 400	9 430 039
Lime	Short tons	68 443	552 411
Marble	Short tons	21 900	140 144
Miscellaneous stone	Short tons	239 820	116 460
Sandstone	Short tons	155 790	323 512
Trap	Short tons	978 070	1 239 255
Talc	Short tons	136 752	1 886 678
Titanium concentrates	Short tons	43 923	*a*
Zinc	Short tons	45 807	8 520 102
Other materials	....	....	2 394 641
Total value	....	....	$108 389 930

a Included under other materials.
b No canvass in 1942.
c Exclusive of limestone used for lime and cement making.
d Included with iron ore.

Mineral production in New York in 1941

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	11 446 292	$16 073 726
Natural cement	Barrels	....	*a*
Brick and tile	....	....	8 111 000
Pottery	....	....	*b*
Crude clay	Short tons	....	*a*
Diatomaceous earth	Short tons	....	*a*
Emery	Short tons	4 876	42 484
Feldspar and quartz	Short tons	....	*a*
Garnet	Short tons	....	*a*
Graphite	Pounds	....	*a*
Gypsum, crude	Short tons	1 080 320	1 500 307
Iron ore	Long tons	1 041 911	5 243 485
Lead	Short tons	2 100	239 400
Millstones	....	....	3 558
Metallic paint	Short tons	9 243	56 900
Mineral waters	Gallons	....	*b*
Natural gas	1000 cu. ft.	10 456 000	7 853 000
Natural gasoline	Gallons	17 000	1 000
Peat	Short tons	13 905	105 120
Petroleum	Barrels	5 185 000	13 300 000
Pyrite	Long tons	63 958	*a*
Salt	Barrels	19 425 614	7 416 734
Molding sand	Short tons	624 448	1 010 051
Other sand and gravel	Short tons	14 298 701	9 086 824
Sand-lime brick	Thousands	....	*a*
Slate	Short tons	....	685 145
Silver	Ounces (troy)	37 734	26 833
Granite *c*	Short tons	394 680	368 284
Limestone *d*	Short tons	8 964 970	8 985 614
Lime	Short tons	62 339	463 230
Marble	Short tons	....	*a*
Miscellaneous stone *c*	Short tons	201 650	118 708
Sandstone	Short tons	129 020	368 697
Trap	Short tons	687 510	806 955
Talc	Short tons	153 560	1 917 732
Zinc	Short tons	38 446	5 766 900
Other materials	....	....	2 031 017
Total value	....	....	$91 582 704

a Included under other materials.
b No canvass in 1941.
c Includes crushed and broken stone only. Dimension stone included under other materials.
d Exclusive of limestone used for lime and cement making.

Mineral production in New York in 1940

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	8 251 038	$11 687 089
Natural cement	Barrels	....	*a*
Brick and tile	....	....	5 820 000
Pottery	....	....	*b*
Crude clay	Short tons	....	*a*
Diatomaceous earth	Short tons	....	*a*
Emery	Short tons	1 046	9 349
Feldspar and quartz	Short tons	....	*a*
Garnet	Short tons	....	*a*
Graphite	Pounds	....	*a*
Gypsum, crude	Short tons	798 229	1 037 181
Iron ore	Long tons	874 339	4 031 086
Lead	Short tons	1 973	197 300
Millstones	....	....	*a*
Metallic paint	Short tons	....	*e*
Mineral waters	Gallons	....	*b*
Natural gas	1000 cu. ft.	12 187 000	8 246 000
Natural gasoline	Gallons	17 000	1 000
Peat	Short tons	19 352	148 433
Petroleum	Barrels	4 999 000	11 600 000
Pyrite	Long tons	64 498	233 816
Salt	Barrels	15 126 221	6 523 775
Molding sand	Short tons	413 391	688 806
Other sand and gravel	Short tons	12 811 472	6 950 862
Sand-lime brick	Thousands	....	*a*
Slate	Short tons	....	479 053
Silver	Ounces (troy)	35 720	25 401
Granite	Short tons	717 480	684 558
Limestone *c*	Short tons	7 667 450	7 874 567
Lime	Short tons	54 364	408 645
Marble *d*	Short tons	16 520	74 265
Miscellaneous stone *d*	Short tons	166 940	107 147
Sandstone	Short tons	399 540	620 464
Trap	Short tons	873 860	1 030 725
Talc	Short tons	113 611	1 402 524
Zinc	Short tons	35 686	4 496 436
Other materials	....	....	1 741 023
Total value	....	....	$76 119 505

a Included under other materials.
b No canvass in 1940.
c Exclusive of limestone used for lime and cement making.
d Includes crushed and broken stone only. Dimension stone included under other materials.
e Included with iron ore.

Mineral production in New York in 1939

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	6 853 796	$9 866 102
Natural cement	Barrels	....	*a*
Brick and tile	....	....	6 883 109
Pottery	....	....	*b*
Crude clay	Short tons	....	*a*
Diatomaceous earth	Short tons	....	*a*
Emery	Short tons	765	6 828
Feldspar and quartz	Short tons	....	*a*
Garnet	Short tons	....	*a*
Graphite	Pounds	....	*a*
Gypsum, crude	Short tons	709 495	971 229
Iron ore	Long tons	712 760	3 441 558
Lead	Short tons	2 387	*a*
Millstones	....	....	2 584
Metallic paint	Short tons	....	*d*
Mineral waters	Gallons	....	*b*
Natural gas	1000 cu. ft.	29 222 000	15 201 000
Natural gasoline	Gallons	34 000	800
Peat	Short tons	18 306	116 875
Petroleum	Barrels	5 098 000	10 650 000
Pyrite	Long tons	71 176	*a*
Salt	Barrels	14 582 086	5 855 422
Molding sand	Short tons	354 113	578 110
Other sand and gravel	Short tons	12 254 015	6 471 994
Sand-lime brick	Thousands	....	*a*
Slate	Short tons	....	465 837
Silver	Ounces (troy)	37 250	25 285
Granite	Short tons	826 630	727 206
Limestone *c*	Short tons	8 200 380	7 430 857
Lime	Short tons	42 225	314 457
Marble	Short tons	8 080	90 415
Miscellaneous stone	Short tons	221 140	199 237
Sandstone	Short tons	312 890	668 207
Trap	Short tons	1 134 570	995 110
Talc	Short tons	99 880	1 252 525
Zinc	Short tons	36 014	3 745 456
Other materials	....	....	2 449 357
Total value	....	....	$78 409 560

a Included under other materials.
b No canvass in 1939.
c Exclusive of limestone used for lime and cement making.
d Included with iron ore.

Mineral production in New York in 1938

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	5 720 922	$7 893 270
Natural cement	Barrels	....	*a*
Brick and tile	....	....	4 442 414
Pottery	....	....	4 651 644
Crude clay	Short tons	....	*a*
Diatomaceous earth	Short tons	....	*a*
Feldspar and quartz	Short tons	....	*a*
Garnet	Short tons	....	*a*
Graphite	Pounds	1 100 000	*a*
Gypsum, crude	Short tons	601 394	941 744
Iron ore	Long tons	435 761	1 841 455
Lead	Short tons	....	*a*
Millstones	....	920	920
Metallic paint	Short tons	....	*d*
Mineral waters	Gallons	....	*b*
Natural gas	1000 cu. ft.	39 402 000	19 419 000
Natural gasoline	Gallons	27 320	1 541
Peat	Short tons	14 131	79 297
Petroleum	Barrels	5 045 000	9 550 000
Pyrite	Long tons	63 772	*a*
Salt	Barrels	12 264 743	5 467 077
Molding sand	Short tons	249 792	403 418
Other sand and gravel	Short tons	13 316 578	6 089 681
Sand-lime brick	Thousands	....	*a*
Slate	Short tons	....	446 081
Silver	Ounces (troy)	37 200	24 048
Granite	Short tons	797 100	857 230
Limestone *c*	Short tons	7 817 680	7 902 074
Lime	Short tons	39 439	302 360
Marble	Short tons	21 370	110 101
Miscellaneous stone	Short tons	216 850	137 939
Sandstone	Short tons	282 560	519 637
Trap	Short tons	925 690	1 000 471
Talc	Short tons	86 423	1 110 024
Zinc	Short tons	29 896	2 870 016
Other materials	....	....	1 834 729
Total value	....	....	$77 895 931

a Included under other materials.
b No canvass in 1938.
c Exclusive of limestone used for lime and cement making.
d Included with iron ore.

Mineral production in New York in 1937

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	6 106 083	$8 825 785
Natural cement	Barrels	....	*a*
Brick and tile	....	....	5 435 096
Pottery	....	....	6 318 456
Crude clay	Short tons	6 465	41 020
Diatomaceous earth	Short tons	....	*a*
Emery	Short tons	320	2 780
Feldspar and quartz	Short tons	....	*a*
Garnet	Short tons	....	*a*
Gypsum, crude	Short tons	700 357	1 107 175
Iron ore	Long tons	851 286	4 017 759
Lead	Short tons	....	*a*
Millstones	....	....	*a*
Metallic paint	Short tons	....	*d*
Mineral waters	Gallons	....	*b*
Natural gas	1000 cu. ft.	21 325 000	12 388 000
Natural gasoline	Gallons	32 953	2 366
Peat	Short tons	10 928	23 788
Petroleum	Barrels	5 478 000	14 140 000
Pyrite	Long tons	74 834	*a*
Salt	Barrels	14 891 907	5 795 551
Molding sand	Short tons	382 402	703 901
Other sand and gravel	Short tons	12 118 986	5 783 333
Sand-lime brick	Thousands	....	*b*
Slate	Short tons	....	365 024
Silver	Ounces (troy)	41 500	32 100
Granite	Short tons	804 230	788 748
Limestone *c*	Short tons	8 875 350	8 705 783
Lime	Short tons	55 947	438 151
Marble	Short tons	21 960	126 983
Miscellaneous stone	Short tons	122 672	163 573
Sandstone	Short tons	293 590	588 331
Trap	Short tons	841 400	978 901
Talc	Short tons	96 140	1 215 834
Zinc	Short tons	32 690	4 249 700
Other materials	....	....	1 496 532
Total value	....	....	$83 734 670

a Included under other materials.
b No canvass in 1937.
c Exclusive of limestone used for lime and cement making.
d Included with iron ore.

CEMENT

New York possesses abundant raw materials for the manufacture of both portland and natural cements. Limestone, the chief raw material now used for portland cement, is widely distributed in the State in formations from the Precambrian to the Devonian. Local supplies of marl, clay and shale are also available. Gypsum, used as a retarder in the set of cement, is obtained from local gypsum mines. For those plants that use slag instead of clay or shale there is abundant material in the Buffalo district.

The impure magnesian limestones, suitable for the manufacture of natural cement, are restricted to the waterlime beds of the upper Silurian formation, known as the Bertie, the Rondout and one or two thin beds in the upper part of the Manlius formation. These waterlime beds occur within a vertical distance of about 100 feet. They extend from Erie county on the west through Onondaga and Schoharie counties and southward along the west side of the Hudson river into the Rosendale district of Ulster county. Nearly all the natural cement produced in the State has been from the four counties mentioned.

PORTLAND CEMENT

The shipment of portland cement from New York mills in 1948, amounting to 12,299,226 barrels, valued at $26,071,417, was the largest ever recorded in the State. New York is a large consumer of portland cement and some of its requirements are met with shipments from other states, especially Pennsylvania. On the other hand, New York cement is shipped to outside centers, mainly New England, which has only one cement plant. As a cement-producing state New York ranks well among the 34 cement-producing states in the Union. In 1946 it stood fourth, both as to quantity and value of cement produced. The three leading states were Pennsylvania, California and Texas in the order named. During the depression years production of portland cement in New York was well maintained as compared with other states. In 1933, at the height of the depression, New York ranked second only to Pennsylvania in the amount of cement produced. In the accompanying table are shown the production and shipments of portland cement since 1937:

Production and shipments of portland cement in New York, 1937-48

YEAR	PRODUCTION BARRELS	SHIPMENTS	
		Barrels	Value
1937	5 912 772	6 106 083	$8 825 785
1938	5 807 731	5 720 922	7 893 270
1939	6 867 614	6 853 796	9 866 102
1940	8 437 368	8 251 038	11 687 089
1941	11 444 508	11 446 292	16 073 726
1942	11 067 269	11 027 118	16 030 995
1943	6 162 085	5 914 660	8 765 665
1944	4 050 872	4 411 695	6 839 676
1945	5 102 160	5 578 906	9 009 454
1946	10 638 826	10 514 431	17 547 319
1947	11 186 952	11 592 821	21 060 957
1948	12 338 481	12 299 226	26 071 417

DEVELOPMENT AND GROWTH OF THE PORTLAND CEMENT INDUSTRY IN NEW YORK

The first commercial operations for the manufacture of portland cement did not begin until some 60 years after natural cement was first produced during the building of the Erie canal. The earliest portland cement plant was completed in 1881 by the Walkill Portland Cement Co. at Carthage Landing, near Beacon, on the Hudson river. The supply of limestone was from the vicinity of Kingston and the burning was in upright kilns with coke as a fuel. In 1883 a second plant with a daily capacity of 200 to 300 barrels was erected at South Rondout, near Kingston, where successful experiments were made with a rotary kiln using oil for fuel, said to be the first venture of its kind in America. This plant was destroyed by fire in 1889.

In the period between 1886 and 1901, six portland cement plants, utilizing marl instead of limestone, were erected in the western section of the State, and for several years outnumbered the portland cement plants using limestone. The first of the cement plants using marl was erected by T. Millen & Sons at Warners, Onondaga county, in 1886. In 1890 the plant was sold to the Empire Portland Cement Co., which continued to operate for a period of about 15 years. In 1892, the American Cement Company started shipments of cement from a newly constructed plant at Jordan, Onondaga county. The raw materials were marl and local clays. The plant was shut down in 1900 when the company built a new plant at Egypt, Pa.

The first portland cement plant in Steuben county was completed in 1892 by T. Millen & Co. in the town of Wayland. A second plant in Steuben county was completed near Perkinsville in 1896 by the Wayland Portland Cement Company. Both of the Steuben county plants used marl and clay for raw materials. The Duryea Portland Cement Company erected a plant at Montezuma, Cayuga county, about 1890. The plant, which operated on marl and clay, was destroyed by fire in June 1893 and was not rebuilt. The last of the portland cement plants to use marl was one located near Caledonia, Livingston county. The plant was completed in 1901 by the Iroquois Portland Cement Company with an office in Buffalo. In May 1910 it was taken over by the Marengo Portland Cement Company, which discontinued production about 1910 and in 1912 the plant was dismantled. Since the closing of the Caledonia plant, limestone has been used in all the portland cement-making plants in the State. After costly operations it was found that, from an economic standpoint, marl could not compete with limestone, even though cement made by using marl was of excellent quality.

At the beginning of 1900 there were seven plants in the State producing portland cement. Two of these used limestone, the others marl. The first of the plants to use limestone was the Glens Falls Portland Cement Company with operations at Glens Falls, Warren county. The plant was erected in 1894 and is still one of the active producers of cement. The second plant to use limestone was the Helderberg Cement Company located at Howes Cave, Schoharie county, which started production of portland cement in 1898. For some years previous to that date the company had produced natural cement from the impure magnesian limestones found below the base of the limestones now used in making portland cement. The Howes Cave plant is at present operated by the North American Cement Corporation, which also operates a plant near Alsen, Greene county. The offices of the company are at 41 East 42d street, New York.

A considerable part of the manufacturing capacity of the State's cement plants is represented by five mills along the Hudson river below Albany, three in Greene county and two in Columbia county. They are all within ten miles of one another and have the advantage of easy access to tidewater and to important markets on the adjacent seaboard.

A brief history of the five Hudson River cement plants follows: The first Portland cement plant in Greene county was erected by the Catskill Cement Company above Smith's Landing on the west side of the Hudson river during 1899 and made the first shipments of the "Catskill" brand of cement in July 1900. The limestone is taken from the high ledge of limestones, Manlius to Becraft, located at Cementon, about one-half mile back from the river. The limestone is transported from the quarries in an overhead bucket cableway that crosses the state highway leading from Catskill to New York. About 1910 the name of the plant was changed to Alpha Portland Cement Company. The company has offices at Easton, Pa.

The portland cement plant, now owned by the Lehigh Portland Cement Company, was originally constructed and first operated in 1901 by the Alsen's American Portland Cement Company, a German firm. The plant is located on the West Shore railroad at Alsen, close to the Helderberg limestone ledges and about one mile north of the quarries operated by the Alpha Portland Cement Company. During World War I the property was taken over by the alien property custodian, but the plant continued operations under the original name for several years. In 1921 it was operated by the Rosoff Engineering Company and in the following year by the Hudson Valley Portland Cement Corporation. This company carried on until 1925 when plant and quarries were acquired by the Lehigh Portland Cement Company of Allentown, Pa. The Lehigh company discontinued operations in 1928, but about ten years ago the plant was rebuilt and equipped with modern machinery and has been an active producer since.

The portland cement plant of the North American Cement Company is located between Alsen and Catskill, with quarries in the same ledges of Helderberg limestone which supply the two cement plants, Alpha and Lehigh, farther south. The plant was originally constructed by the Seaboard Cement Company of Alsen, organized in 1908. The company, however, never operated the plant and about 1914 the property was taken over by the Acme Cement Company, which made extensive alterations and improvements, including a change from the "dry" to the "wet" process of manufacture. Production was begun in 1916. In 1926 the plant became affiliated with the North American Cement Company, which also operates the cement plant at Howes Cave.

The Hudson Portland Cement Company was the first plant to operate in Columbia county, starting production in 1904. The limestone used was from the nearby Becraft mountain, an isolated outlier of Silurian and Devonian limestones containing essentially the same formations as those that supply the limestone for the portland cement used in the plants of the Cementon-Catskill region. In 1908 the Hudson Company was acquired by the Atlas Portland Cement Company, which erected a much larger plant about two miles southeast of Hudson, near Jonesburg. A private railroad connects the new plant with the old mill, which for a time served as a supplementary mill, and also with the docks on the Hudson river. After the erection of the new plant, which began production in 1910, it was operated by an affiliated company known as the New York and New England Cement & Lime Company. In 1929 the Atlas Company was taken over by the Universal Atlas Cement Company, a subsidiary of the United States Steel Corporation. The main office of the company is at 135 East 42d street, New York.

The Knickerbocker Portland Cement Company was organized in 1908 and shortly thereafter began the erection of a plant on Becraft mountain near the city of Hudson. Active manufacture of cement began in the summer of 1911. In 1928 the name of the operating company was changed to the Lone Star Cement Company. The company office is at 75 State street, Albany.

The first portland cement plant in central New York to use limestone was erected in 1901 by the Cayuga Portland Cement Company, at Portland Point on Cayuga lake in Tompkins county. The raw materials used were the Tully limestone and the underlying Moscow shale. This was the first cement plant in the State to use shale instead of clay. For a few years previous to 1926 the cement works were operated by the Cayuga Operating Company, Inc., a subsidiary of the Pennsylvania Cement Company. In 1926 the property was acquired by the Pennsylvania-Dixie Cement Corporation of Nazareth, Pa., which conducted operations until the spring of 1947. In that year the plant was closed and has not been reopened. Another portland cement plant in central New York was erected in 1913 by the Millen Portland Cement Company. The location is at Jamesville, Onondaga county. The limestone used is from the nearby quarries of the Solvay Process Company, the smaller sized crushed stone being employed for cement. The plant has been operated for the past 30 years by the Alpha Portland Cement Company of Easton, Pa.

In 1927 two portland cement plants were completed in western New York, in the Buffalo district. One of these was that of the Federal Portland Cement Company with offices at Buffalo. The plant is situated to the south of the city on the shore of Lake Erie. The raw materials used are limestone and slag, the latter from the local steel furnaces. The rated capacity of the mill when built was 1,200,000 barrels of cement annually. The other Buffalo plant was constructed by the Great Lakes Portland Cement Corporation. The plant is located near the southern city line of Buffalo, not far from the Lackawanna plant of the Bethlehem Steel Corporation. The limestone used is received in crushed form by boat from quarries in Michigan and the shale from Shaleton, 12 miles south of the plant. The rated capacity of the plant is 2,500,000 barrels annually. The gypsum used in both of the Buffalo plants is from western New York mines, some of which are but a short distance from Buffalo. In October 1941, the Great Lakes Portland Cement Company was taken over by the Lehigh Portland Cement Company of Allentown, Pennsylvania. For several years previous to this date, the Great Lakes Company had been operated as a subsidiary by the Lehigh.

Portland cement production. From the time the first portland cement plant was established in the State in 1881, the production of portland cement has shown a rapid growth and now ranks high among the mineral industries of the State. At times the industry has suffered serious setbacks as the result of business, labor or war conditions, but it has been quick to respond with increased production when business returned to normal.

In 1890 nine years after the establishment of the first plant, the output of portland cement in the State amounted to 65,000 barrels. The million barrel mark was reached in 1902, and in 1906 the output of portland cement of 2,423,374 barrels exceeded for the first time that of natural cement which had fallen to 1,691,565 barrels in the same year. By 1913 production was in excess of 5,000,000 barrels annually. There was a slump in production for the years 1918, 1919 and 1921, followed by an upswing with an annual production of over 10,000,000 barrels for the four years following 1926. The year 1931 saw a decline culminating in 1933 in a record low for recent years with shipments of but 3,966,696 barrels. By 1936 production had again reached the 5,000,000 barrel mark. Production since 1937 is shown in the accompanying table. Altogether, the shipments of portland cement made in New York for the 1890-1948 period have amounted to 290,391,751 barrels.

NATURAL CEMENT

Natural cement is made from the so-called waterlime rock, an impure magnesian limestone. The rock is also known as natural cement rock and, in the manufacture of cement, does not require the addition of clay or shale as does portland cement, in which a purer limestone is used.

The discovery that certain limestones when calcined did not slake, but after grinding developed hydraulic properties, was made during the building of the Erie canal. The quarry where cement rock was originally obtained was in the town of Sullivan, Madison county, and the product of the first efforts at cement making was used in the locks and walls of the Erie canal in 1818 and 1819. On the basis of the discovery of a method of making natural cement, a patent was taken out by Canvass White. In 1825 the State of New York purchased the patent rights for the use of the people of the State. Cement works were established in the Kingston-Rosendale district, which soon became the center of the natural cement industry. The records show that in 1840 there were 16 plants with a total of 60 kilns engaged in the manufacture of natural cement. Mather estimated the production for that year at 400,000 barrels. Peak production was reached in 1899 when the output amounted to 4,689,167 barrels. In the same year production of portland cement totaled only 472,386 barrels. There were 33 natural cement plants in 1899, of which 19 were in Ulster county, ten in Onondaga county and four in Erie county. After 1900 the natural cement industry rapidly declined. In 1908 production fell below the one million-barrel mark and by 1918 had dwindled to scarcely more than 10,000 barrels annually. The decline in the natural cement industry may be attributed to the growing popularity of portland cement and the lower costs at which the latter could be produced. The open quarry methods used in obtaining limestone for portland had several advantages over the underground mining of the natural cement rock. Moreover, fewer and larger plants in the portland cement industry made it possible to produce a more uniform product.

In recent years there has been a moderate revival of the natural cement industry. This has been brought about as a result of an effort to adapt natural cement to special uses rather than to compete with portland cement on a broad basis. Natural cement is used for mortar in brick and stone work, in which plasticity and ease of working, as well as strength, are essential. Absence of stain or run after set is also a desirable feature of the product.

In 1926 the Louisville Cement Company of Louisville, Ky., put in operation a new natural cement plant, located near Akron, Erie county. The material is from the waterlime beds of Salina age, the same as that which was formerly employed by the now dismantled plants at Akron. The product is for use in mortars and is marketed as "Brixment." A second plant, the Century Corporation of Rosendale, began operations in 1929 after taking over and remodeling the natural cement plant formerly owned by A. J. Snyder & Company. The product made there, which has all the requisites of a good mortar, is sold under the name "Brixmortar." In addition to the special mortar cements both companies produce some regular natural cement.

CLAY PRODUCTS

The clay and shale deposits suitable for common wares are widely distributed in New York State. Building materials rank first in bulk and value of output and are supplied mostly to local markets, which normally consume large quantities of clay. The Hudson River district, one of prime importance, has supplied brick to metropolitan New York. Syracuse, Buffalo and Binghamton, among other cities, obtain at least a part of their requirements from local yards.

Very few high-grade kaolin clays were left in New York after the stripping action of the last glacier. Most of the deposits were laid down in glacial waters and consist of rock flour ground up by the glacier. Most of the material is native to the locality, but part may have been carried for some distance. The workable clays were deposited in the quiet waters of the glacial lakes and are found today as terraces above the level of the present rivers or in valley bottoms or depressions which were the sites of temporary bodies of water. They range in thickness from a few feet to over 100 feet. Their normal color is blue, but in the upper beds exposed to the action of weathering processes they may be yellow from oxidation of iron. Beds of sand are frequently interstratified with them indicating a periodic change to conditions of more rapid deposition.

These glacial clays are adapted to common brick manufacture, land tile and materials of that sort. As a rule they contain relatively large proportions of iron, lime-magnesia and alkalies—fluxing ingredients —and thus vitrify at low temperatures. The product usually is red or pink in color.

PRODUCTION

The manufacturers of clay products in New York have never been able to recover from the tremendous decline in sales of building materials which accompanied the business depression starting in 1930. Moderate increases were stifled by the war and it is only since 1946 that production has begun to rise to predepression levels. The postwar increase in business and domestic construction has revived the industry although the number of producing plants is greatly reduced. Hudson River brick producers have now embarked on a research program to insure technological advances and a more uniform product. The values of various types of clay products, as far as they are available, are given in the annual tables of mineral production in New York.

ALBANY SLIP CLAY

Production of slip clay is centered around Albany; deposits have been found north to Mechanicville and south to Catskill. It occurs interbedded with the ordinary brick clays of the middle Hudson valley and differs only in being more "greasy" and in having less prominent sand partings. A satisfactory slip clay contains a high percentage of fluxing impurities and is of such texture that it melts at fairly low temperatures and forms a greenish or brown glass which is free from lumps or air bubbles. Actual firing tests are necessary to determine whether a particular bed is slip clay or not. Its use as a slip in glazing pottery wares is best known. Much of the domestic stoneware is thus glazed. Electric insulators for high-tension transmission lines are often glazed with Albany clay. Another use has been made of the clay in the manufacture of carborundum and emery abrasive materials; the granular abrasives are mixed with a small proportion of slip clay and then molded into forms, after which they are fired. The slip clay is preferred to other clays for the purpose on account of its low fusion point.

BRICK SHALES

Shale deposits of New York State constitute yet another vast ceramic resource. They are especially adapted to the making of vitrified paving brick and ornamental brick.

The Devonian formations outcrop in the southern part of the State in east-west trending belts. The Hamilton, Portage and Chemung groups include interbedded sandstones and shales of considerable thickness. The shales range in composition from normal clay shales to very siliceous shales. It is therefore necessary to make individual tests for physical and chemical properties at specific localities. Brick of equal quality to that made from fire brick of nearby States has been made from the Devonian shales. Among the localities where these shales have been used for brick are Angola and Jewettville, Erie county; Jamestown, Chautauqua county; Olean, Cattaraugus county; Alfred Center, Allegany county; Corning and Hornell, Steuben county; Newfield, Tompkins county; Binghamton, Broome county; and Catskill, Greene county.

The Hudson River shales which extend along the Hudson above the Highlands are partly metamorphosed and develop little plasticity when ground. It is possible that some of the more argillaceous types might be used for brick manufacture if they were mixed with the plastic clays of the region.

The Salina, Clinton and Queenston formations contain much shale, but so far it has not been used widely for ceramic purposes.

DIATOMACEOUS EARTH

Diatomaceous earth, or diatomite as it is also called, is a friable, finely divided, earthy deposit found in certain fresh water lakes and ponds and consists of the remains of microscopic plants called diatoms. In general appearance diatomaceous earth resembles chalk or fine marl, but its base is silica instead of lime carbonate and it can be easily distinguished from either by the fact that it does not effervesce when immersed in acid. Chemically, it differs from ordinary quartz in that it shows the presence of considerable water combined with the quartz, and mineralogically it may be regarded as the opal variety of silica.

The principal deposits of diatomaceous earth are found in some of the Adirondack lakes. The best known deposit is in White Lead lake in northern Herkimer county, which has been the main source of supply of diatomaceous earth in the State for a period of about 60 years. The material is mined by the Adirondack Diatomaceous Earth Company, with offices at Keene, N. H. Other lakes in the southern Adirondacks which are reported to contain diatomaceous earth, nearly all of which are state-owned, include Riley (Roily) pond, Clear lake, Big Crooked lake, Hawk lake and Chub lake. On the West Canada Lake quadrangle, four state-owned lakes contain diatomaceous earth. They are Sampson lake, Sampson bog, Cat lake and Mud lake. In the town of Hope, Hamilton county, white material from beaver huts in Bennett lake proved to be diatomaceous earth. This lake, also, is state-owned.

No detailed survey has been made to determine the amount of diatomaceous earth present in the Adirondack lakes. The deposits are found not only in existing lakes and ponds, but in extinct lake bottoms where the material may be concealed by swamp deposits such as muck. It has been estimated that two or three million cubic yards of diatomaceous earth may be present in the Adirondack region. Single deposits in the area have been estimated to contain from 100,000 to over 1,000,000 cubic yards each. The beds have a reported maximum thickness of 30 feet, but the average thickness is, no doubt, considerably less. In one five-acre deposit west of Big Crooked lake the thickness is from two to 12 feet with an average of about three feet.

The diatomaceous earth produced in New York State is used entirely in the manufacture of silver polish. Other requirements for which relatively large quantities of diatomaceous earth are in demand include its use in filtration processes, fillers, insulation and its incorporation in concrete mixtures. Only a small amount of the total produced in the United States is used for abrasive purposes. Most of the diatomaceous earth is now mined in the states west of the Rocky mountains, with California the chief producer. In the east, New York is the only producing state at present, but a few years ago a deposit was worked in New Jersey.

There would be a good market for large supplies of diatomaceous earth from the Adirondacks if it could be mined economically. One of the chief difficulties in the further development of the industry is the fact that several of the largest and best known deposits are on state land where, in many cases, legal restrictions prevent active mining operations.

EMERY

The entire domestic supply of emery comes from New York mines southeast of Peekskill. Other domestic sources of emery, in Massachusetts and Virginia, have not been operated in recent years. The Peekskill deposits have been under operation for over 50 years and have contributed the bulk of the output. The New York emery is somewhat softer than that imported from Turkey and Greece and is, therefore, of greater importance in polishing pastes and compounds than in grinding wheels. In recent years, a large percentage of the production has been used in surfacing concrete floors in order to prevent them from becoming slippery, even when wet.

New York emery is classed as a spinel emery, as the ordinary magnetite-corundum mixture is diluted with varying percentages of the spinel mineral groups. Sillimanite, cordierite, garnet and quartz are important accessory minerals. Corundum accounts for as much as 50 per cent of the total. The relative abundance of this extremely hard and tough mineral determines the quality of the product. The rock is shipped from the mine in the rough.

The Peekskill emery district is limited to that area of basic igneous rock known as the Cortlandt series. These gabbroic rocks were intruded into the Manhattan schist, probably in late Paleozoic time. The emery is a result of end stage contact metamorphism, after emplacement of the rock.

According to Newland, "The emery occurs in the form of schlieren and irregular bodies, distributed here and there over the area. Some deposits are near the edge of the igneous area, others are at a distance inland from the borders. The large part of the output has been taken from the eastern section, in the area northeast of Pleasantside and farther south near Dickenson pond and Salt hill. The extraction of the ore is carried on by open cutting on the outcrop, or by driving short tunnels or inclines on the trend of the deposit. No deep workings have been undertaken and are hardly warranted by the small size of the operation. The ore when broken is sorted roughly as to its physical characters and probable corundum content, and the different grades are hauled to Peekskill for treatment."

Production of emery has mounted steadily from 1938 when all mines were closed down. The price F.O.B. New York City has gradually increased from $8.70 a short ton in 1937 to $12.85 a ton in 1948. Wartime inability to import emery from Greece was important in stimulating domestic production.

Emery production 1937-48

YEAR	SHORT TONS	VALUE
1937	320	$2 780
1938	No report	......
1939	765	6 828
1940	1 046	9 349
1941	4 876	42 484
1942	5 277	49 413
1943	6 666	63 195
1944	6 940	64 858
1945	7 856	75 977
1946	6 188	62 099
1947	5 798	66 927
1948	5 405	69 408

FELDSPAR AND QUARTZ

Feldspar is one of the minor industrial minerals produced in New York State. Because of its importance as an igneous rock-forming mineral, its commercial occurrences are limited to the Precambrian rocks of the Adirondacks and the Hudson highlands. The only feldspar deposits that have been worked in New York are pegmatites, coarsely crystalline masses which are associated with granitic rocks. These may grade imperceptibly into granitic wall rock or may cut sharply across associated rock masses. Feldspar also occurs as one of the major minerals in granite and similar rocks, but so far it has not been considered economical to crush the rock and separate the feldspar from the other rock-forming minerals. Usually quartz, mica, tourmaline and sometimes beryl are found accompanying feldspar in New York pegmatite deposits.

Microline or orthoclase, the potash feldspars, are the varieties considered most desirable. The theoretically pure mineral contains 64.7 per cent SiO_2, 18.4 per cent Al_2O_3 and 16.9 per cent K_2O. There is always, however, a small percentage of albite feldspar present as an intergrowth and so every analysis will show a small percentage of soda. Potash feldspars are considered especially desirable for whiteware bodies.

Albite is the soda feldspar. This forms a continuous series with the lime feldspars so that any proportion between the two may exist. Pure albite contains 68.7 per cent SiO_2, 19.5 per cent Al_2O_3 and 11.8 per cent Na_2O. Most New York pegmatites run to mixtures of potash and soda feldspars.

High-lime feldspar makes up over 90 per cent of anorthosite, an igneous rock which underlies the "High Peak" area of the Adirondacks in Essex and Herkimer counties. No use has been made of this material to date, except as building stone. Rock of similar composition has been tested in Wyoming as a source of alumina.

PRODUCTION

Since 1930 the annual production of feldspar has not risen above 10,000 tons. In recent years crude feldspar has been mined only at the Bedford, Westchester county, quarries of the Consolidated Feldspar Corporation. Other companies which have mined and ground feldspar during the period covered by this report are: Atlas Feldspar Corporation, Saratoga county; Crown Point Spar Company, Inc., Essex county; and White Hill Mineral Company, Inc., St Lawrence county.

Imported feldspar is ground by the Consolidated Feldspar Corporation and by the Genesee Feldspar Company, Inc., both at Rochester.

Canadian nepheline syenite is imported and ground at Rochester by the American Nepheline Company. This is a feldspar substitute.

By-product quartz has been ground by the Consolidated Feldspar Corporation and by the Atlas Feldspar Corporation as late as 1942. Quartz pebbles from the Olean conglomerate were separated and crushed in southwestern New York during the war years. It is understood that the silica was used for ferro-silicon manufacture at Niagara Falls.

USES OF FELDSPAR

The major use of feldspar, particularly the soda varieties, is in the glass industries. About two-thirds of all feldspar produced goes for this purpose. High potash varieties are in continued demand for ceramic bodies. As much as 55 per cent may be used in floor tile, while 16 to 17 per cent is the average proportion in china. Enamels and glazes can make use of the soda feldspars. Other important uses are in soaps and scouring powders as a binder and in abrasive wheels and dental porcelain.

GARNET

New York has continued to occupy its pre-eminent position in garnet production. This is a result, in large part, of increased production from the world's largest garnet mine, that of the Barton Mines Corporation at North Creek. From 1939 to 1945 this mine supplied the only New York contribution to the national total. Mining at the deposit of the Warren County Garnet Mills ceased in 1937, but garnet was sold from stock in 1938. By-product production began from the wollastonite deposit of Northern Minerals, Inc. (originally, estate of John Burnham) of Essex in 1945. Inasmuch as the market for garnet is largely dependent on the activity in the building trades, production rose sharply after the war. The price of Adirondack garnet concentrate has been maintained at $85 per ton.

Garnet occurs as an important rock-forming mineral in gneiss and gabbro throughout the Adirondack region. In certain localities, notably the northwest corner of Warren county, and adjacent parts of Essex and Hamilton counties, it is found in sufficient quantity to mine. The usual variety is almandite, a garnet which is somewhat harder than other types. Another very desirable feature is its regular parting which causes the garnet to break with sharp chisellike edges.

The Gore Mountain deposit of the Barton Mines Corporation is characterized by single garnet crystals up to two or three feet in diameter, lying in a lense of hornblende-feldspar rock, 50-100 feet wide between syenite and gabbro. Comparatively few of the crystals, however, exceed a few inches in diameter. Chief impurities are mica, chlorite and hornblende.

According to Newland, the deposit formerly worked by the Warren County Garnet Mills is a somewhat different type. "The garnet is in small grains or crystals intergrown or intermixed with green pyroxene, the two minerals constituting the entire rock body. In places the garnet is practically free of admixture. The color is light red or pink, forming a variegated pattern with the pyroxene."

The garnet obtained as a by-product of wollastonite mining and beneficiation by Northern Minerals, Inc. near Willsboro is of two types: red-brown andradite occurs in layers intercalated with the wollastonite, and iridescent colophonite garnet occurs as irregular masses and stringers.

The most important recent development has been in treatment of the ore. Garnet was first separated from the waste rock by hand picking, later by jigging. In 1942 a heavy-media process of separation was initiated at the mill of the Barton Mines Corporation. The specific gravity of the ferro-silicon suspension is maintained between 3.10 and 3.25. This process has resulted in increased recovery of garnet (95-98 per cent), greater tonnage handled per man hour, recovery of more garnet in the —½ inch +⅛ inch range, and saving in cost.

Garnet ground to very fine sizes (about 1600-mesh), is now being used for precision lense grinding. According to Oliver Bowles, "tests have shown that it may be substituted for corundum or superfine abrasive powders, although a 20 per cent increase in grinding time is required. Roasting 20 to 40-mesh garnet increases its grinding efficiency, and tests are now in progress to determine the improvement that may result from roasting the fine powder." The garnet from Willsboro was quarried and used for lens-grinding abrasive during the first World War. Tests carried on by the United States Bureau of Mines indicate that it is quite satisfactory under present-day requirements.

In November 1943, the Barton Mines Corporation began production of fine optical abrasives in a new mill designed for the purpose. Grinding of old waste garnet, previously rejected as too fine grained, is done in a chrome steel ball mill. Sizing is done by gravity in a column of water. In the earlier operations 20 per cent of the original garnet was wasted. This can now be rehandled for the new product.

GRAPHITE

Production of natural graphite in New York, after several years resumption, ceased again in January 1942. Hopes that the flake graphite mines of the eastern Adirondacks would be reopened were dashed by the capture of Madagascar from the Vichy French and by resumption of shipments from Ceylon. Earlier experiments by the United States Bureau of Mines indicated that the weathered ores of Pennsylvania, Alabama and Texas were more readily susceptible to crushing and beneficiation than the hard New York quartzose schists.

The only mine in continuous operation from 1937 to 1942 was that at Pope's Mills. This was reopened in 1937 by the Long Valley Ore Company and leased by them early in 1941 to the St Lawrence Graphite Company, a subsidiary of the Asbury Graphite Mills of Asbury, N. J. The ore is said to have run 20-25 per cent graphite and was flake graphite of foundry grade. Average production in 1940 and 1941 was 65 tons a day. Beneficiation was carried out by crushing and flotation at the Morristown mill run by the operators. The resulting product ran 85-90 per cent carbon and was sold mainly for use in dry batteries and for foundry facings.

At this locality the graphite occurs as a graphite schist and was worked down the dip of a plunging, faulted anticline. The high grade soft ore petered out at depth and was replaced by a leaner, harder type. Exploration failed to show an extension of the better quality ore and the mine was closed down in the spring of 1942.

The St Lawrence Graphite Company also produced some graphite of a similar type from a deposit on the Fleming farm, exactly three miles due south of Rossie. It is a disseminated deposit in the Grenville limestone and was worked by an open pit in the hillside. Because of transportation problems and the difficulty of securing a clear title, the lease was canceled.

The graphite deposits of the eastern Adirondacks, which have not been worked since 1921, are a source of Madagascar type flake, as well as occasional masses of pure Ceylon-type plumbago. They have not, however, been able to compete with the foreign production and it is doubtful if they can be operated economically in the near future.

These deposits are a result of recrystallization of Precambrian sedimentary rock, the graphite being an original constituent. The most important type occurs as distinct flakes in a quartzose schist separated by gangue minerals such as quartz, feldspar, mica and pyrite. The graphite-containing beds are discontinuous and strongly folded so that underground mining is the most efficient method of extraction. The extensive crushing which is necessary in order to separate the flakes from the hard unweathered rock results in a product which is finer and therefore less desirable, than Madagascar flake.

The coarser graphite, which occurs in veins and irregular masses, similar to Ceylon plumbago are in Grenville limestone or limestone-granite contacts. These bodies are usually of too limited extent to be mined systematically.

The principal graphite localities of the eastern Adirondacks as listed by Newland and Hartnagel (N. Y. S. Mus. Bul. 319, p. 47-49, 1939) are:

Chilson hill, three miles northwest of Ticonderoga, Essex county, one of the well-known localities. Graphite occurs as veins and pockets in limestone close to granite, also to some extent in the granite itself. The first mining operations were undertaken here, apparently antedating 1840, as indicated by the description given in Beck's Mineralogy of New York, published in 1842. The mines were worked by the American Graphite Company, and the output, as indicated by the many pits, chambers, drifts and shafts still in evidence, was considerable, although not of record.

American mine of the Joseph Dixon Crucible Company, situated at Graphite, Warren county, five miles west of Hague, on Lake George. Operations were carried on for 40 or more years, ceasing in 1921. The ore, consisting of quartzite with 5 per cent or more of graphite, was crushed and the graphite recovered in a local mill. The concentrates were then shipped to Ticonderoga for refining and preparation for the market. The production of this mine was larger than that of any other Adirondack property, and its aggregate shipments probably were the largest of any mine in the country.

Faxon mine, adjoining the American, and worked in later years in connection with it.

Lakeside mine, at Hague, also operated at one time by the Joseph Dixon Crucible Company.

Mines of the Crown Point Graphite Company, near Penfield pond and Paragon (Chilson) lake, Essex county, ten miles northwest of Ticonderoga. They were last worked about 1910.

Mine of the Columbia Graphite Company, near Round pond, northwest of Ironville, town of Crown Point, Essex county. Operations were carried on in 1903 and 1904, when the company moved its plant to Rock pond, town of Ticonderoga.

Mine of the Columbia Graphite Company, at Rock pond, Essex county, worked in 1904 and 1905. Later the property was worked by Pettinos Brothers.

Mine of the International Graphite Company, Chester township, Warren county. Active about 1901.

Mine of the Rowland Graphite Company, six miles southwest of Riverside, Warren county. Worked at intervals from about 1901 to 1910.

Mines of the Adirondack Mining and Milling Company, west side of South Bay, town of Dresden, Warren county, three miles due west of Whitehall. Worked between 1904 and 1907.

Mine of the Champlain Graphite Company, in same locality as the one just mentioned and worked at about the same time. Nearby was the property of the Silver Leaf Graphite Company which prospected a deposit but did not erect a mill.

Mine of Hooper Brothers, about two miles west of South Bay and five miles straight west of Whitehall, in town of Dresden, Warren county. It started operations in 1916 and was one of the important shippers in subsequent years. The concentrates produced in the mill were retreated in a plant at Whitehall.

Mine of the Glens Falls Graphite Company, near Conklingville, Saratoga county. Work began in 1906. In 1911 the Sacandaga Graphite Company took over the property.

Mine of the Saratoga Graphite Company, one mile southwest of Kings Station, town of Wilton, Saratoga county, and four miles north of Saratoga Springs. Operations began about 1910, and in 1914 the property was taken over by the Graphite Products Corporation, which enlarged the capacity for mining and milling and continued work for a few years.

Mine of the Empire Graphite Company, four miles west of Kings, Saratoga county, first operated about 1907 and active during two or three years. About 1917 this property was taken over by the Flake Graphite Company.

GYPSUM

Gypsum was first discovered in New York State at Camillus, Onondaga county, in 1792. During the 1810-20 period small quarry operations were carried on at Camillus and in the town of Sullivan, Madison county. The product of the quarries was used locally for agricultural purposes. The opening of the Erie canal in 1825 provided a wider market, and gypsum quarries were soon established at other localities along the Salina belt containing the gypsum deposits. Among the towns in the vicinity of which quarries were opened were Fayetteville, Union Springs, Seneca Falls, Phelps, Le Roy and Wheatland.

During the period when gypsum was used almost exclusively for agricultural purposes the annual production rarely exceeded 34,000 tons. The enlargement of the gypsum industry came shortly after 1893 when the application of calcined gypsum in the process of manufacturing wall plaster and related building materials was successfully inaugurated at Oakfield, Genesee county. In 1893, only 75 tons of calcined plaster were reported, as compared with 33,781 tons sold in the crude state. By 1899 the quantity of gypsum used for calcined plaster exceeded that used for all other purposes. Another impetus that encouraged the development of the gypsum industry was the requirement of the fast-growing portland cement industry for gypsum as a retarder to delay the set of cement. In 1905 when, for the first time, the production of portland cement in the State exceeded 2,000,000 barrels, 34,095 tons of gypsum were sold to cement mills. In the same year calcined plaster totaled 130,268 tons, and the production of agricultural plaster was 19,815 tons.

The annual production of crude gypsum in New York has fluctuated considerably during the past 30 years. In 1917 a mine output of 606,268 tons set a new high mark for gypsum production up to that date. During the 1922-29 period the annual production exceeded 1,000,000 tons, with an all-time record of 1,730,254 tons of gypsum in 1925. During the depression years production of gypsum declined, and the mine output in 1933 of 363,745 tons was lower than for any time in the preceding quarter of a century. With improved business conditions following 1933, the quantity of gypsum mined annually again increased, and for each of the years 1941 and 1942 the output exceeded 1,000,000 tons. In 1945 production had fallen to 557,902 tons, but in 1948 the crude gypsum mined again exceeded 1,000,000 tons.

Since 1889 statistics on the mine or quarry production of gypsum have been collected annually. From 1889 to 1948 inclusive, New York has contributed a total of 34,784,752 short tons of crude gypsum. The output from the early part of the nineteenth century to 1889 can not be stated definitely, but on the basis of available data it would appear to have been about 2,400,000 tons, making an aggregate production of 37,184,752 tons for the entire period of operations.

The accompanying table gives the mine production and value of crude gypsum for the 1937-48 period.

Production and value of crude gypsum in New York, 1937–48

YEAR	PRODUCTION SHORT TONS	VALUE
1937	700 357	$1 107 175
1938	601 394	941 744
1939	709 495	971 229
1940	798 229	1 037 181
1941	1 080 320	1 500 307
1942	1 012 987	1 605 530
1943	713 961	1 229 796
1944	594 067	1 128 821
1945	557 902	1 262 989
1946	814 999	1 961 157
1947	949 375	2 613 094
1948	1 228 358	3 294 973

In the previous issues of the bulletins of the New York State Museum on the Mining and Quarry Industries of New York State, dating back to 1904, the value of sales of gypsum has been based on the amount sold as lump or ground and that sold calcined as wall plasters and other gypsum building materials. This method was used because it represented the actual amount of sales of crude or processed gypsum in its first marketable form. Early efforts to obtain the value of the crude gypsum at the mine did not prove very satisfactory. Some of the gypsum companies which did not sell any of their crude gypsum reported only a nominal or inventory value for the gypsum, which in some cases was less than the actual cost of mining. With the increasing demand and a wider field for gypsum in portland cement requirements, it has been possible in recent years to make a more reliable estimate of the value of crude gypsum at the mine. In our statistical tables the change in 1937 to the use of the estimated value of crude gypsum at the mine, rather than the value of the sales of gypsum and its products, is in conformity with the practice initiated by the United States Bureau of Mines, with which the State Museum cooperates in the collection of mineral statistics. As a result of the present arrangement, the amount and value of crude and ground gypsum sold is no longer available for the individual states.

It is to be regretted that under the present method of collecting gypsum statistics, it will be difficult to harmonize gypsum values with those published in former years. Likewise, consideration must be given to the change in values when the tables showing the State's total annual mineral production for different years are compared.

Although no statistics are available since 1936 on the amount and value of crude gypsum sold, it has been possible to obtain the quantity and value of calcined products, such as wall plasters, made from local gypsum for the years shown in the accompanying table.

Calcined products made from local gypsum, 1942–48

YEAR	CALCINED GYPSUM SHORT TONS	VALUE
1942	529 616	$2 439 984
1943	506 177	2 805 805
1944	372 781	1 158 580
1945	394 994	1 951 849
1946	545 686	3 735 566
1947	625 513	4 267 028
1948	696 087	4 647 079

In order that a comparison may be made with the method of recording gypsum production and values previous to 1937, the accompanying table covering the 1921-36 period is presented herewith.

Output of gypsum and its products for the 1921–36 period

YEAR	MINE OUTPUT SHORT TONS	SOLD AS LUMP OR GROUND SHORT TONS	SOLD AS WALL PLASTERS, BOARD, BLOCKS ETC. SHORT TONS	VALUE OF SALES
1921.......	712 665	206 304	418 695	$6 410 221
1922.......	1 055 302	281 530	631 735	8 807 366
1923.......	1 361 116	230 080	823 241	10 344 745
1924.......	1 474 491	335 841	1 019 319	14 329 246
1925.......	1 730 254	354 394	1 185 142	16 219 906
1926.......	1 723 460	328 086	1 246 822	16 794 589
1927.......	1 675 501	290 368	1 291 967	14 889 390
1928.......	1 504 826	268 691	1 068 222	9 613 307
1929.......	1 284 338	298 793	859 147	8 339 852
1930.......	912 070	275 294	573 602	7 059 108
1931.......	744 613	222 072	459 676	6 111 853
1932.......	408 208	134 246	271 114	4 213 793
1933.......	363 745	109 569	221 987	3 646 109
1934.......	391 408	131 925	237 438	3 922 529
1935.......	485 792	139 755	334 668	5 377 587
1936.......	609 204	185 155	398 700	6 585 277

For very many years New York ranked first among the gypsum-producing states. Since 1945 the production of crude gypsum in Michigan has exceeded that of New York. Other important gypsum-producing states include California, Iowa, Nevada, Texas and Virginia.

The gypsum deposits of New York are the most easterly in location in the United States and the industry depends to a great extent upon the seaboard markets as an outlet for its gypsum products. Over a number of years this trade has been supplied on an increasing scale by imports of gypsum from New Brunswick and Nova Scotia. The imports, mostly in crude form, go to tidewater calcining plants for manufacture. The gypsum brought in from Canada has in some years exceeded the total mined in the State. The waterborne gypsum bears low transportation charges as compared with rail shipments, which fact makes competition with our own local supplies possible. The importation of crude gypsum is likely to offer even more serious competition with the local product in future years.

At present, two calcining plants, operating on imported gypsum, are located on the New York seaboard. One of these is in the Bronx, where the National Gypsum Company calcines gypsum imported from Walton, Nova Scotia. The other plant is operated by the United States Gypsum Company, and is located at New Brighton. The gypsum calcined at this plant is from Windsor, Nova Scotia.

DISTRIBUTION AND RESOURCES OF GYPSUM IN NEW YORK

The commercial gypsum deposits are limited to beds usually within the upper hundred feet of the Camillus formation, which is of upper Silurian age. The Camillus shale includes numerous thin-bedded magnesian limestones with the gypsum beds parallel to those of the limestone. The quarrying or mining of gypsum has been carried on at various places from Madisôn county at the east to Erie county at the west, a distance of about 165 miles.

The high-grade gypsum suitable for calcined building materials and obtained by mining is limited to the western 50 miles of the district in Monroe, Genesee and Erie counties. The remainder of the district has produced only gypsum for agricultural uses and for cement retarder. With the exception of one underground mine in Ontario county, all the gypsum produced in the eastern section has been by the open quarry methods.

One of the best guides to the occurrence of gypsum in the field is the presence of the cherty beds of the Onondaga limestone. The northern limits of this formation are usually indicated by a sharp break in the topography or by a line of cliffs. The uppermost gypsum beds lie just north of the Onondaga and usually occupy a strip of low ground a mile or more in width in which there are few outcrops. The southerly or southwestern dip of the gypsum beds of 50 to 75 feet a mile corresponds closely to that of the Onondaga limestone.

The occurrence of gypsum or hydrated calcium sulphate is limited in depth to about 250 feet. At greater depths along the dip of the rocks the gypsum is succeeded by beds of anhydrite which consist of calcium sulfate without combined water and are of little or no commercial value.

In the gypsum-mining operations for high grade material in Genesee and Erie counties, the gypsum occurs as one or more interstratified beds in a series of shales and dolomitic limestones. In these two counties most of the mineable gypsum beds range in thickness from three and one-half to five feet and carry a hydrated calcium sulphate content of 90 to 96 per cent.

In certain parts of Monroe county two gypsum seams, each about six feet thick, are separated by six to 12 feet of limestone. The gypsum averages from 75 to 80 per cent hydrated calcium sulphate.

In Ontario county gypsum has been produced from a number of quarries and from a single mine located near Victor. The mine, active from 1929 to 1943 inclusive, produced gypsum from a six-foot vein, which was shipped to cement mills. The Ontario quarries, which had been in operation at various times for nearly 100 years, were last active about 1908. They produced only agricultural gypsum.

The counties of Cayuga, Onondaga and Madison, lying east of Ontario county, were once the scene of a thriving gypsum industry. It was here in the eastern gypsum section that the first quarries for agricultural gypsum were operated in the period between 1810 and 1820. Until the opening of the gypsum mines in western New York near the close of the last century, the thick beds in the eastern section of the gypsum belt had produced most of the gypsum output. With the rapid development of the western New York gypsum mines, the quarries at the east, with their lower gypsum content, assumed less importance and finally ceased operations entirely.

In making any estimate of the gypsum resources of the State, two facts of importance must be held in mind. One of these is that, in following the gypsum down the dip, the gypsum beds are succeeded by beds of anhydrite at a depth of approximately 200 to 250 feet, thus marking a limit to mining operations along the dip of the rocks. The other fact is that in the 165-mile east-west extent of the gypsum deposits, the thickness of the gypsum beds stands in inverse relation to their quality. The thickest beds are found in the eastern counties. The gypsum in a quarry at Lyndon, Onondaga county, has a thickness of 60 feet, and in one at Union Springs, Cayuga county, the gypsum is 30 feet thick. Only thin shale partings are found in these quarries. In composition, the rock in the eastern counties carries 65 to 80 per cent gypsum, with an average of about 68 per cent. In Monroe county, where two gypsum beds are present, each five to eight feet thick, the average content of the rock is about 75 per cent gypsum, with some portions over 80 per cent. In the western district of Genesee and Erie counties, the gypsum beds average four to six feet in thickness with a high gypsum content of 90 to 96 per cent.

An estimate of high grade gypsum deposits in Erie, Genesee and Monroe counties was made by Dr D. H. Newland in 1926. The total resources of the three counties was given as 85 million tons. Some 19 millions tons of high grade gypsum have been mined since 1926, thus leaving 66 million tons still available. The original estimate was based on the single bed mined in Erie and Genesee counties and on the two beds in Monroe county.

If additional beds of gypsum known to exist in the western New York area, but of somewhat lower grade, can be utilized, the resources would probably be double that of the original estimate. Taking into consideration the thick deposits in the central part of the State, with a gypsum content upwards of 65 to 70 per cent, the total reserves would run into hundreds of millions of tons.

The gypsum companies which are active or which have been active at some time during the period covered by this report are the following:

Erie county. The National Gypsum Company works deposits near Clarence Center on the western end of the developed gypsum area. In 1948 the company completed a large addition to their Clarence Center manufacturing plant.

Certain-teed Products Corporation operates a mine and plant at Akron. The company has recently sunk a shaft at Clarence Center and will transport the gypsum to their plant at Akron.

The Universal Atlas Cement Company carries on mining operations at its plant near Clarence Center.

The United States Gypsum Company has a mixing plant at Buffalo, but its New York State gypsum mines are located in Genesee county.

The Atlas Gypsum Corporation produced gypsum for cement mills from the time of its incorporation in 1925, to 1935. The corporation was dissolved in 1936. The mine was located near Clarence Center.

Genesee county. The Phoenix Gypsum Company has a mine near South Alabama (Basom). It produces gypsum for cement mills and sells to other gypsum operators.

The United States Gypsum Company has mines and plants in the vicinity of Oakfield. Some years ago this company acquired the mines and mills of the Niagara Gypsum Company. The combined properties are in the area between Oakfield and South Alabama.

The National Gypsum Company operates a mine and mill in the western part of Genesee county, a couple of miles northeast of Akron.

The Oakfield Gypsum Products Corporation formerly operated a mine and mill two and one-half miles west of Oakfield. The company's last output was in 1938 when the company was dissolved.

Monroe county. The Ebsary Gypsum Company, Inc., mines and mill are located near Wheatland Station. The company produces both crude gypsum for shipment and manufactured products.

At various times between 1932 and 1943, the Dolomite Products Company of Rochester produced gypsum for cement from a mine at Garbutt. The last production was in 1942. The equipment and rights to unmined gypsum were sold to the Ebsary Gypsum Company, which dismantled and closed the mine in 1943.

Two companies which formerly conducted operations were Lycoming Calcining Company and the Empire Gypsum Company. The former discontinued operations in 1931 and the latter in 1929.

Ontario county. At present there is no active gypsum mine in this county. In 1929 the Victor Plaster Company, Inc., opened a mine for the production of cement gypsum, just east of the village of Victor. In 1942 the mine was sold to Roc-Gypsum, Inc. The last production of gypsum was in 1943, and it is reported that the mine has been abandoned.

IRON ORE

Deposits of iron ores of various types are rather widely distributed in New York State. They are, however, naturally grouped in more or less definite areas or regions as determined by geologic and geographic boundaries. The deposits arranged according to geographic areas are as follows:

1 **Adirondack region.** Magnetite ores with occasional hematite (martite) in Precambrian gneisses. Also, titantiferous magnetite in basic igneous rocks of the gabbro family. The Adirondack region has recently become the scene of intensive mining operations.

2 **Highlands of the Hudson.** Magnetite in Precambrian gneisses. Last active mine in 1931. Recent diamond drilling in several districts.

3 **St Lawrence and Jefferson counties.** Hematite associated with crystalline limestone, serpentine and schist of Precambrian (Grenville) age. No active mines at present, but some tests have been made at the old Caledonia mine and other localities.

4 **Central and western New York.** Fossil and oolitic hematite interbedded with limestones and shales of the Clinton group. The only active mine is at Clinton, Oneida county. Until a few years ago, ore was obtained at Fruitland, Wayne county, and at Sterling Station, Cayuga county. In recent years production has been for mineral paint.

5 **Dutchess and Columbia counties.** Limonite associated with crystalline limestones, slates and schists of Cambro-Siluric age. Siderite, the carbonate of iron, sometimes accompanies the limonite. At one mine near Hudson carbonate is the principal ore. Mines have been inactive for a number of years.

6 **Staten Island.** Bog ore (limonite) found in superficial deposits resting on serpentine. Probably no longer of economic importance. A few other deposits of bog ore in various sections of the State at one time supplied small quantities of ore, mostly for local furnaces.

In the present account of the iron ore industry, only the magnetite deposits of the State will be considered. These may be grouped as occurring in two geographical regions—the Adirondacks of northern New York and the Hudson River highlands of southeastern New York.

MAGNETITES OF THE HUDSON RIVER HIGHLANDS

The magnetites of the Highlands region occur in Precambrian gneisses, in acid igneous rocks and along the contact of igneous rocks and limestones. None of the southeastern magnetite mines are active at present.

The first magnetite mine in New York was opened in the Highlands district in southern Orange county in 1750. This was the famous Sterling mine, which had almost continuous operation for more than 150 years. Another well-known magnetite mine was the Forest of Dean, located back of West Point and opened about 1756. The last shipment of ore from this mine was made in 1936 from stocks mined in 1931. On the east side of the Hudson in Putnam county, the best known magnetite mines included the Tilly Foster, Croton, Mahopac and Cold Spring.

Altogether, about fifty mines and prospects have been opened in the Highlands area. Most of these have been small, but the magnitude of certain of the deposits may be gaged by the fact that at Sterling lake one mine had reached a depth of about 9000 feet on the slope and it was still in ore when it was closed in 1921. The vein in the Forest of Dean was mined along the dip for a mile or more without any noticeable change in shape or character of the ore. A few years ago some diamond drilling was done in the Putnam County deposits and in the Sterling Lake area of Orange county, but these operations have not been followed by further development work.

With the exception of a magnetic concentration plant at the Croton mine, operations in southeastern New York have been concerned with ore of direct shipping grade. There are undoubtedly large resources of milling grade ore still available which, it is believed, could be economically beneficiated and could thus reestablish active ore production.

MAGNETITES OF THE ADIRONDACKS

On the basis of their chemical and metallurgical properties, the Adirondack magnetites are divided into two classes, the titaniferous and the nontitaniferous. The nontitaniferous ores have the widest distribution and ordinarily contain less than 1 per cent of titanium dioxide (TiO_2). The titaniferous ores are mixtures of ilmenite ($FeTiO_3$) and magnetite, in which the titanium dioxide content may run to 15 or 20 per cent.

TITANIFEROUS MAGNETITES

The titaniferous ores are found chiefly in the great igneous intrusion of anorthosite and gabbro. This igneous area, some fifty miles across, extends from near the central Adirondacks to Lake Champlain and includes Mount Marcy, the highest mountain peak in the State. Here are found the headwaters of the Hudson river, along which, in the vicinity of Lake Sanford, are situated the largest single group of titaniferous iron ores in the State. The only deposit of titaniferous ore outside of the anorthosite area is near Port Leyden, Lewis county, where it is associated with syenite gneiss and has a titanium dioxide content of about 10 per cent.

NONTITANIFEROUS MAGNETITES

The nontitaniferous magnetites of the Adirondacks have a wide distribution outside of the anorthosite area. In contrast to the occurrence of titaniferous magnetites in anorthosites and gabbros, the nontitaniferous magnetites occur in rocks of syenite or granite and in the banded Grenville series. Altogether, some 120 mines, prospects and pits have been opened in the Adirondacks. Of these, 80 or more have produced magnetite in commercial quantities. The principal localities or districts for magnetite deposits are Fort Ann, Washington county; Hammondville, Crown Point, Port Henry and Mineville, Essex county; Au Sable Forks, Lyon Mountain, Clintonville, Clayburg and Dannemora, Clinton county; Benson mines, Jayville, Parish and Clifton, St Lawrence county. In Herkimer county, the single magnetite mine is near Salisbury. Only a few small bodies of magnetite have been found in Franklin county and these have not been exploited to any extent. At present the only nontitaniferous magnetite mines being operated are the Old Bed-Harmony, the New Bed and the Fisher Hill mines at Mineville, Essex county, the Chateaugay and "81" mines at Lyon Mountain, Clinton county, the Benson mines near Starlake, St Lawrence county, and the Clifton mine near Degrasse, also in St Lawrence county.

The ores range from rich magnetites with 65 per cent or more of iron, down to very lean mixtures of magnetite and gangue minerals. The lower limit is found in ordinary country rocks, such as syenite and granite, which contain small percentages of free iron oxides in the form of magnetite. The Adirondack magnetite mixtures are readily amenable to magnetic mill treatment, as a result of which ore from about 25 per cent iron content upward may have that content raised economically to 60 to 70 per cent, while simultaneously the phosphorus and sulphur content is being reduced to small proportions. Some of the richer ores contain 60 to 70 per cent iron and do not require mill treatment. For example, it is reported that over fifty years ago many carloads of ore containing 72 per cent iron (pure magnetite = 72.4 per cent iron) were shipped from the Lovers' Pit opening on Barton hill near Mineville. This is believed to be the largest quantity of nearly pure magnetite ever shipped in the United States.

TYPES OF ORE AND SHIPMENTS

Magnetite mined in New York is marketed in one of three forms. The first is known as high-grade lump, or direct-shipping, ore. Formerly, this type of ore was obtained by hand-sorting, but at present it is generally recovered by magnetic pulleys. The second type of ore is marketed in the form of concentrates obtained by magnetic treatment of the leaner ores, whereby the iron content may be raised to 60 to 70 per cent. In recent years the third type of ore, in the form of sinter, has gained favor rapidly and most ore is now sent to market in that form.

The sintering process consists of a preliminary furnace treatment of concentrates as a result of which they become a coherent porous mass. The concentrates pass through the furnace on a conveyor belt at the end of which the hot sinter is broken into lumps automatically and may be dropped while still hot directly into cars for shipment.

In the accompanying table are given the production and shipments of iron ore since 1937. The data include the magnetic concentrates and sinter obtained from the titaniferous magnetite mine at Lake Sanford and a relatively small amount of hematite used for the manufacture of paint.

Production and shipments of iron ore in New York, 1937–48

YEAR	CRUDE ORE MINED LONG TONS	ORE SHIPPED LONG TONS	VALUE
1937	922 663	851 286	$4 017 759
1938	313 932	435 761	1 841 455
1939	715 607	712 760	3 441 558
1940	874 046	874 339	4 031 086
1941	1 048 141	1 041 911	5 243 485
1942	1 253 347	1 218 618	10 941 428
1943	3 723 126	1 363 202	11 892 756
1944	4 910 119	1 886 464	15 312 350
1945	5 280 909	1 965 655	15 136 120
1946	1 328 788	960 098	7 819 639
1947	6 265 982	2 513 555	19 673 363
1948	7 856 937	2 932 442	24 384 648

ADIRONDACK MINING DEVELOPMENTS

During the past ten years outstanding history has been made in the iron-mining industry of New York by the entrance into the Adirondack region of several of the major ore-producing companies. These companies include the Republic Steel Corporation, Cleveland, Ohio, Jones and Laughlin Ore Company, Pittsburgh, Pa., and the Hanna Ore Company, Cleveland, Ohio. In addition to the fore-named companies, the National Lead Company, New York, has re-opened and is mining the large titaniferous magnetite deposits on the east shore of Lake Sanford at the newly developed village of Tahawus. The magnitude of the enterprises at the six Adirondack magnetite mines may be more easily comprehended when it is considered that some $40,000,000 in new funds has been spent in development work, mining equipment, beneficiating plants and shipping facilities. When fully developed the estimated annual capacity of the mines is expected to be 4,000,000 tons of high grade ore, mostly in the form of sinter, with an iron content ranging from 60 to 68 per cent iron. In addition to magnetite, one of the mines produces large quantities of ilmenite concentrates containing about 48 per cent titanium dioxide (TiO_2).

NONTITANIFEROUS MAGNETITE MINES

Mineville. The first of the major iron-mining companies to enter the Adirondack region during recent years was the Republic Steel Corporation, which in 1938 leased the extensive holdings of the Witherbee Sherman Corporation of Port Henry, most of which were in the vicinity of Mineville, four miles west of Lake Champlain. Altogether about 12 well-known mines were included in the transaction, and among them were those formerly owned by the Port Henry Iron Ore Company which the Witherbee Sherman Corporation had purchased a few years before.

At the time the Republic company took over the Mineville properties, two ore beds in close proximity to each other were still active producers. More or less parallel, the two beds had a dip of approximately 30 degrees and were separated by a distance of about 700 feet. The upper vein has long been known as the Harmony and the lower as the Old Bed, but in recent years they have been generally referred to as the "Old Bed-Harmony" mine. Although the two beds were connected underground at two different elevations, the ore was mined separately and hoisted through different shafts. Improvements at the mines include an entirely new and inclined shaft built along the Harmony, or upper vein. From the Old Bed, or lower vein, a 1000-foot crosscut provides for the transfer of the Old Bed ore to the new shaft, through which it is hoisted approximately 3600 feet to the surface. The ores from the Harmony and Old Bed veins are of different grades and, although now raised through the same shaft, they are beneficiated and shipped separately. During the past two or three years shipments from Mineville have included ore from the New Bed lying west of the Old Bed group of mines.

Other improvements at Mineville include a change from the dry to the wet milling process. Due to limited water supplies, only primary and secondary crushing, with the elimination of as much rock as possible, is done at Mineville. The resulting material, crushed down to —¼ inch, which was formerly sent to Port Henry on Lake Champlain for final treatment, is now processed at the Bartlett Pond brook plant where the ores from the Fisher Hill mine are beneficiated. The concentrating plant at Port Henry was closed in 1944. It consists of two units, one for making Harmony concentrates, the other for Old Bed concentrates. Adjacent to the concentrating plant is an intermittent type of sintering plant, also consisting of two units and likewise used, one for handling Old Bed concentrates, the other for the Harmony material. The Port Henry plants are located along the main line of the Delaware and Hudson railroad so that the concentrated or sintered ore can be loaded directly into cars. The plants can be reopened any time new or surplus ores become available.

In addition to ore shipped as concentrates and sinter, some high grade, or direct-shipping, ore is produced from the Old Bed vein. This ore, amounting to as much as 25 per cent of the total crude production, was formerly obtained by handsorting from a slow-moving pan-conveyor, but selection is now accomplished by magnetic pulleys after which it is ready for shipment and loaded into railroad cars.

It is estimated that the improvements made at Mineville will make it possible to produce 1,800,000 long tons of crude ore a year. When beneficiated, this amount will yield approximately 1,000,000 long tons of shipping ore.

Fisher Hill. The Fisher Hill mine is located less than two miles north of Mineville. The mine was one of the early producers of the region and was closed down in 1893. About 1920 diamond drilling proved the Fisher Hill ore body contained at least 40,000,000 long tons of milling ore. In 1923 operations were started to dewater the mine, but the work was not completed.

At the beginning of World War II, in order to make more iron ore available, the Republic Steel Corporation prepared plans for the development of the Fisher Hill ore body. These plans were approved in September 1941 by the Defense Plant Corporation and called for the development of the mine with a capacity for production of 2,500,000 long tons of crude ore annually. Work was immediately begun to carry out the project. The mine was dewatered, modern equipment installed and production of crude ore started on a limited scale during 1943.

Owing to inadequate supplies of water at Fisher Hill, the concentrating plant, using the wet process, was located at the Switchback on Bartlett Pond brook about three and one-half miles from the mine and three miles from Port Henry on Lake Champlain. An auxiliary water supply is available through a 16-inch pipe from a pumping station on the lake. The concentrating plant, which was completed in the late summer of 1943, consists of three independent units and has a capacity of 300 long tons of finished product an hour. The sintering plant is of the continuous type and is equipped with two units, each with a capacity of 1500 long tons in 24 hours. The sinter and unsintered concentrates reach the Port Henry district over the Lake Champlain and Moriah railroad, the same line that transports the products from the Mineville mines.

Lyon Mountain. In volume of iron ore production, the Lyon Mountain, or Chateaugay, mines have been second only to those of the Mineville district. As early as 1871, regular shipments began, the ore going by wagon to Catalan forges where it was converted into bloom iron. In 1879 a railroad was extended from Plattsburg to Lyon Mountain, affording facilities for shipment of ore to more distant points. In 1903 the Lyon Mountain mines were taken over by the Chateaugay Ore and Iron Company by whom they were operated until 1939, when they were leased to the Republic Steel Corporation.

The ore deposits at Lyon Mountain occur in several parallel and folded stringers, which are continuous for several miles. Present operations are in an ore bed that is several thousand feet long at the surface. The mineable thickness is about 15 feet and the inclined shaft is bottomed at a depth of about 2400 feet. The ore from the working faces of the mine[1] is transported to the hoisting shaft by storage-battery locomotives.

The ore bodies in the Lyon Mountain district are noteworthy for their large size, but their iron content is often as low as 25 per cent. After crushing, the iron content may be raised by concentration to 65 to 68 per cent. Some of the very fine material is concentrated to 70 per cent iron—only 2.4 per cent below that of pure magnetite. The concentrated ore is in high repute since it contains only minute quantities of sulphur and phosphorus—much below the admissible limits for Bessemer ores.

A few years ago the concentrating mill was changed to use the wet process. Its capacity is rated as capable of treating 4500 long tons of crude ore every 24 hours. A small quantity of the ore is shipped as concentrates but most of it is sintered. The sintering plant, which uses the continuous process, is able to produce about 60 long tons of sintered ore each hour.

Benson Mines. The Benson mines are located in the town of Clifton, St Lawrence county, about 70 miles west of the iron mines at Mineville. The ore bodies were mentioned in reports published as early as 1842, and previous to this date it is recorded that some ore had been transported from Benson Mines to Canton for reduction. Regular shipments did not begin, however, until 1889 when the railroad entering Jayville, 14 miles away, was extended to Benson Mines. During the years 1886-1888, the Magnetic Iron Ore Company operated mines at Jayville, but on completion of the railroad, the company abandoned the Jayville workings and started operations at the Benson mines. A concentrating mill was erected on the property

[1] Underground mining has recently been supplemented by open cut methods at the old "81" several miles west of the Chateaugay ore bed.

and mining continued until the depression of 1893. The mines were again worked in 1900 and 1901, and during this two-year period 70,000 tons of concentrates, averaging 63 to 64 per cent iron, were produced. The low phosphorus content of but .037 per cent make the ores suitable in furnaces producing Bessemer and foundry irons.

It has been estimated that during the 1889-1901 period the Benson mines produced 370,000 long tons of crude ore which, when milled, yielded approximately 150,000 long tons of concentrates of 60 per cent iron. About 1907 the Magnetic Iron Ore Company was purchased by the Benson Mines Company and operations were begun in the fall of that year. The equipment for the open pit mine included steam shovels, crushers, dry concentrating machines and gas producers for firing the two-kiln nodulizing plant. A hydroelectric plant was erected at Brown's Falls a few miles away. A number of improvements were made in 1914, including a change from a dry to a wet concentrating plant and the installation of wet magnetic separators. During the cold winter months, however, ice conditions at the power plant made it impossible to supply power to the mine. This, together with high production costs and the falling off in the demand for iron ore, led to the abandonment of the enterprise in 1919.

Activity at the Benson mines was resumed in July 1941, when the Jones and Laughlin Ore Company leased the mine and adjacent property consisting of some 3200 acres from the Benson Iron Company. The new operations were planned to produce 400,000 long tons of sintered ore a year, but at the request of the Federal Government the capacity was raised to 1,000,000 long tons annually. Financing of the larger project was accomplished through a loan of nearly $7,000,000 through the Defense Plant Corporation. Modern equipment was installed at the mine, which is of the open cut type. The blasted ore from the quarry face is loaded by a five-yard electric shovel into side-dump trucks of 35 yards capacity. The coarse crushing mill is partly below ground and is capable of crushing approximately 1000 tons of ore an hour. From the coarse crushing mill, conveyors transport the material to a secondary crusher and then on to the fine crushing plant. On completion of the crushing process, the ore goes to the concentrating plant which is supplied with rod-and-ball mills and magnetic separators. The magnetite is then conveyed to a sintering plant equipped with two continuous sintering machines. The tailings, or waste from the concentrators, are pumped to a large disposal area through a pipe laid on a trestle. The capacity of the disposal pipe is 6000 tons of tailings a day.

The ore body at Benson Mines is very large. It extends from a point a mile or more west of present operations easterly past the plant for another mile or more toward Newton Falls. The surface width of the vein varies from 80 to 400 feet. Results of recent drilling operations are not available, but some years ago a vertical test 180 feet deep encountered ore all the way. Analyses of ten samples of ore ranged from 32 to 44 per cent iron. The average iron content of the ore as mined at present is reported to be from 25 to 30 per cent, which is brought up to 60 to 65 per cent in the concentrates. Shipments of concentrates from the new developments at Benson Mines began in November 1943 and in February of the following year the sintering plant commenced operations.

Clifton. The Clifton magnetite mines are located about ten miles north of the Benson mines. They were first operated in 1858 or perhaps a few years earlier. A charcoal furnace was built at Clarksboro at the falls of Grass river, three miles from the mines, and was run for some time on the ore. In 1868 the Clifton Mining Company, which then owned the property, erected a plant near the mine for manufacturing steel by a direct process. The venture was short lived, but a few years ago the 160-foot brick stack, bearing the date 1868, was still standing. During these early operations a 20 mile narrow-gage wooden railway was constructed from the mines to connect with the Rome, Watertown and Ogdensburg railroad near DeKalb Junction. On the basis of old pits and tunnels affording evidence of the extent of the early mining ventures, it has been estimated that not more than 10,000 tons of ore were removed before the mines shut down.

After a series of tests by magnetometer and diamond drilling in 1940, the M. A. Hanna Company of Cleveland, Ohio, undertook the development of the Clifton Mines property in July 1941. The mine is now operated by the Clifton Mine division of the Hanna Coal & Ore Corporation located at Degrasse. Preliminary operations included the establishment of headquarters at the hamlet of Degrasse, from which a rough trail was cleared through heavy timber to the mine five and one-half miles away. Through this road, tractors and teams transported lumber and cement for use in structures at the mine. In the meantime a well-graded highway was under construction. Other construction included the building of a 14-mile telephone line from Edwards, an eight-mile power line from Brown's Falls and a 12-mile railroad from Newton Falls. Before completion of the railroad an electric shovel and electric blast-hole drills were trucked in from the railroad station at Oswegatchie, 22 miles away. In December 1941 the first train arrived at the mine bringing structural steel and mill machinery. Mining equipment was now supplemented by a Diesel-powered shovel, wagon drills and five 15-ton rear-dump trucks. Water for the mill operations was obtained from the Grasse river, two miles away, by two 1000-gallon-per-minute pumps. Ore of milling grade was stock-piled during construction, but in June 1942 the first car of direct-shipping ore was loaded.

The beneficiation plant, which has a daily capacity of 1800 long tons of ore, consists of five buildings. The first contains the primary crusher and reduction crushers; the second, the secondary crusher and the magnetic pulleys by which the direct-shipping ore is separated; the third, the wet grinding and wet separation machines. The fourth building houses the pug mill and the fifth, the sinter machine. The sinter machine is a 72-inch 12-wind-box type with oil-fired ignition. The mixture carried on the conveyor belt through the furnace consists of 60 to 65 per cent concentrate, 4 per cent fine coal and 30 to 35 per cent of fine sinter returns. The coarse sinter above one and one-fourth inches drops directly into water-sprayed railroad cars. The analysis of the sintered product is iron 62.45, silica 4.97, sulphur 0.010 and phosphorous 0.021 per cent. The iron content of the lump, or direct-shipping ore, is 58.16 per cent.

The initial mining operations at the Clifton mines by the Hanna Ore Company employed the open cut method which made possible continuous production while an underground mine was being developed. The first cut was opened from the hanging-wall side of the ore body, the second midway in the ore body from the footwall side. Since the completion of the mine shaft, drifts and working levels, open cut mining of ore has gradually given way to underground methods.

TITANIFEROUS MAGNETITE MINE AT LAKE SANFORD

The titaniferous magnetite deposits of the Lake Sanford area lie in the heart of the Adirondacks. The deposits have been known since 1826. In that year a ledge, or dam, in the Hudson river, consisting of solid iron ore was noted. As early as 1830 some ore transported to Lake Champlain for testing was found to contain iron of satisfactory quality. In 1837 a puddling furnace was erected at the mine then known as the Adirondac Iron Works; two years later the enterprise was incorporated as the Adirondac Iron and Steel Company. A small blast furnace was erected and the young industry continued to grow. Among other structures erected were a cupola furnace, a forge and a stamping mill. In 1854 a new and larger furnace was completed. It was 36 feet square and 48 feet high, with a daily capacity of 12 to 15 tons of ore. The lower part of the furnace is still standing.

Activity at the mines continued until the panic of 1857. Efforts to sell the property were without success and it was not until 1894 that it was taken over by a newly organized company called the MacIntyre Iron Company. The attempts of the new company to utilize the ore were not commercially successful. The presence of a considerable percentage of titanium had the effect of stiffening the slag in the blast furnace charges, thus rendering the ore almost unworkable.

In 1909 the property of the MacIntyre Iron Company came under the control of Wallace T. Foote, and under his direction activities were resumed. New roads were opened, possibilities of water power were investigated, and a railroad from Sanford mountain to Ticonderoga, a distance of 60 miles, was surveyed. An extensive diamond drilling program was conducted at each of the four ore bodies in the immediate vicinity of Lake Sanford. In the Sanford Hill ore body directly east of Lake Sanford, 32 diamond drill holes were put down, the average depth of which was nearly 200 feet. The deepest hole, bottomed at 924 feet, was still in ore when drilling ceased. The estimated reserves of the Sanford Hill ore body, based on magnetic surveys and diamond drilling as determined by the MacIntyre Iron Company, was 24,263,772 long tons for ore that ran more than 45 per cent iron. In the Iron (Ore) Mountain deposit, one and one-half mile north of the Sanford Hill ore bed, seven holes were drilled. The deepest was 357 feet and the average of the seven holes about 190 feet. The tonnage for this ore body was estimated at 17,415,914 long tons. In the Calamity-Mill Pond area, lying about one-half mile west of Ore Mountain, three drill holes and a magnetic survey indicated an ore reserve of 9,101,872 tons. The Cheney ore deposits lie about one and one-half miles west of Lake Sanford. Several shallow drilling tests have been made at the Cheney site and there is a small mine opening. The ore body is reported to be about 1400 feet in length and 800 feet in width. No estimate of ore reserves is available.

Due to the death of Mr Foote in 1910, activities at Lake Sanford were greatly curtailed. In 1912, however, another effort was made to test these titanium-bearing ores in modern smelters in order to determine whether or not they could be successfully utilized in the manufacture of steel. To carry out the plan a crusher and separating plant was erected at the ore body on the east shore of Lake Sanford. During 1912 about 15,000 tons of ore were taken out for treatment. The concentrates were hauled some 30 miles to North Creek on sled trains drawn by steam tractor engines—transportation that was supplemented by teams and motor trucks. From North Creek the material was shipped by rail to the Cedar Point furnace at Port Henry. The results of the furnace test appear to have been highly successful, but commercial development of the mining property was not undertaken.

One of the chief obstacles that always confronted development of the property had been its remoteness from any well-developed lines of transportation. As planned by the MacIntyre Iron Company, a rail route was to be built, terminating at a point on Lake Champlain some 62 miles from Lake Sanford. More than $100,000 was spent in preliminary work on this railroad, but it was never carried through and no further mining of ore was undertaken by the MacIntyre Iron Company. The natural outlet for Lake Sanford ores was by way of the Hudson valley to the existing railroad at North Creek that had been completed in 1863. Unfortunately, the building of a railroad from Lake Sanford to North Creek was blocked by the necessity for crossing State lands within the Forest Preserve. Normally, such a crossing could not be accomplished without an amendment to the State Constitution. This situation was changed, however, under the broad powers given the President during World War II, by which he was enabled to delegate the Federal Defense Plant Corporation to proceed with the building of the 30-mile railroad, which was completed in June 1944.

In 1941 the titaniferous magnetite ore bodies in the vicinity of Lake Sanford were acquired by the National Lead Company. One of the main objects in taking over the property was to obtain a supply of titanium ores, the imports of which had been cut off by the war. The ore body chosen by the National Lead Company for development was the one at Sanford Hill directly on the east shore of Lake Sanford. By core-drilling, a volume of ore, all above lake level, containing some 15,000,000 tons, was blocked out. The titaniferous magnetite ore body is a mixture of magnetite and ilmenite, the latter consisting of 31.6 per cent oxygen, 36.8 per cent iron and 31.6 per cent titanium (52.7 per cent TiO_2). The titanium dioxide constitutes about 16 per cent of the crude ore. As a result of the crushing and milling of the ore three separate materials are produced. These are, first, the ilmenite concentrates, containing about 48 per cent titanium dioxide, second, the magnetite concentrates, containing about 89 per cent magnetite, 9 per cent titanium dioxide, 1 per cent silica and a fraction of 1 per cent vanadium pentoxide (V_2O_5). The third product is waste rock material.

The plant as designed at Lake Sanford has a milling capacity of about 4000 long tons of ore daily, with a production of 800 tons of ilmenite and 1600 tons of magnetite concentrates. Before the construction of the railroad to North Creek, the ilmenite concentrates were hauled by truck, part of the distance being over a new road constructed by the company. By the middle of July 1942, only a year after construction began, the plant was in operation. During this period extensive stripping operations were in progress and the open cut bench type of mining was developed. The buildings, several of them very large, include crushers, separators and concentrators. A 42-mile power line was built from Ticonderoga over the right of way of the company. A two-unit reservoir of 1,100,000 gallon capacity was constructed to supply the mine and community needs for water. A short distance south of the mine a village was built, which has been named Tahawus.

Previous to the opening of the railroad in June 1944, some of the magnetic concentrates had been transported to the railroad at North Creek by trucks, but considerable amounts had been stock-piled at the mine. The completion of the sinter plant in June 1944, coincided, except for a few days, with the opening of the railroad which now serves to transport all the products from the mine.

In addition to the titaniferous magnetite of the Lake Sanford region, there are in the Adirondacks a number of other deposits of this type of ore to which brief reference will be made in the chapter on titanium dioxide.

LEAD

Galena (PbS), the chief source of lead, has been mined in New York State at various times during a period of more than 100 years. Since the opening of the Balmat zinc mine, located in St Lawrence county in 1928, there has been reported an annual production of lead. At the Balmat mine the galena, or lead ore, is associated with the more important ore of zinc (sphalerite). There is present also a considerable quantity of pyrite, which, together with the zinc and lead ores, forms the three merchantable products of the mine. In addition, when refined, the galena yields eight to ten ounces of silver per ton of ore treated. Two other zinc mines in St Lawrence county, namely the Hyatt and the Edwards, are singularly free of important quantities of galena, although at the Williams shaft of the Edwards mine specimens with cleavage faces an inch or more across have been found.

During the progress of the First Geological Survey of New York State, 1836-40, there was considerable activity in lead mining at several localities in St Lawrence county. One of the active lead mines, known as the Coal Hill vein, was located in the town of Rossie. This vein was first mined about 1836 and operations continued for several years, during which time records indicate 3,250,690 pounds of metallic lead were produced. In 1852 operations were revived by another company known as the Great Northern Lead Company. This company employed experienced miners from Cornwall, England, and mining continued for two or three years. Later the mines were leased to J. B. Morgan who operated them for several years. In 1868 the mine was finally closed and has remained idle since.

Another lead mine in the town of Rossie was opened about 1836 and is known as the Victoria, or Pardee, mine. The mine lies along a low ridge about one mile northeast of the Coal Hill vein. A shaft reported to be 300 feet deep was sunk on the property at the base of the ridge and there were several shafts along the top. A separating works and smelter were erected, but there appears to be no record of the output of metallic lead.

In the town of Macomb, St Lawrence county, a deposit of galena was discovered about 1836 at Mineral Point on Black lake, and in 1839 a company known as the Mineral Point Lead Manufacturing Co. was organized to develop the deposit. The outcome of this venture is not known, but some 25 years later the property was leased to J. B. Morgan, who for a time operated the Coal Hill mine.

Also in the town of Macomb are the galena deposits on the Downing, Jones and Pennock farms. The main activity at the Pennock mine was carried on about the middle of the past century, at which time a furnace was in operation on the property. Activity was renewed in the early years of the present century, and from the Pennock mines a considerable quantity of ore was obtained.

Another deposit of galena in the town of Macomb is on the Turner farm three miles north of Brasie Corners, where, about the year 1907, operations were in progress. According to information supplied by John Sullivan of Gouverneur, a vein of galena was also worked some 25 years ago on what is known as the Claude Mosher farm. The vein is located just east of the St Lawrence Marble Co. quarry at Gouverneur. During the prospecting stage eleven tons of galena were shipped.

In the town of Alexandria, Jefferson county, galena has been found in a railroad cut one mile north of Redwood station. The vein, which intersects the Potsdam sandstone, consists mainly of calcite containing small quantities of galena.

In the Shawangunk mountain region of Ulster, Orange and Sullivan counties, lead mines have been operated for lead alone or for lead and zinc at Ellenville, Summitville, Spring Glen and at two localities near Guymard. All are in the Shawangunk grit, or conglomerate, which is of Silurian age. In recent years attempts have been made to renew mining operations. At Summitville the mine was active as late as 1918 when the St Nicholas Zinc Co. reported a production of 29 tons of lead and 129 ounces of silver.

In the town of Ancram, Columbia county, is another deposit of galena where lead containing a little silver was mined many years ago by a company known as the Ancram Lead Mines. Shafts, underground workings and large accumulations of waste indicate rather large-scale operations, but the enterprise was never profitable. In the town of Northeast, Dutchess county, a vein of galena is reported to have been worked as early as 1740, and the ore to have been shipped to Bristol, England, for treatment. The mine was reopened during the Revolutionary War and a few tons of lead were produced.

Other localities in New York State where galena has been found include White Creek, Washington county, and several occurrences in the Mohawk valley—among them Sprakers Basin and East Creek; also, at Schoharie, Schoharie county, and Martinsburg, Lewis county. In the Lockport dolomite of central and western New York, galena may be found in the lining of small cavities, but these have little more than mineralogical interest.

The production of lead since 1939 is given in the accompanying table. The low production for the year 1945 was due principally to labor shortage.

Production of lead in New York, 1939–48

YEAR	SHORT TONS	VALUE
1939	2 387	*a*
1940	1 973	$197 300
1941	2 100	239 400
1942	2 434	326 156
1943	2 355	353 250
1944	1 644	263 040
1945	862	148 264
1946	1 073	233 914
1947	1 496	430 848
1948	1 231	440 698

a Permission to publish was not obtained.

MAGNESIUM

Stimulated by war demands, a greatly expanded market for magnesium metal developed after 1940. In 1943 a government-financed plant near Wingdale, New York, began to produce metallic magnesium from native dolomite by ferro-silicon reduction. This method, known as the Pidgeon process, was selected by a special committee of the National Academy of Sciences as the one which would give the best results in the least time and with the most efficient expenditure of funds. These plants were authorized by the Defense Plant Corporation, of which the New York plant operated by the American Metal Company was one. It was designed to produce a minimum of 10,000,000 pounds of magnesium metal yearly. In 1944 it was closed down after 11 months of operation. This was a result of overexpansion of magnesium producing facilities at about the time the heaviest war demand diminished. Part of the plant facilities were bought early in 1948 by the D. H. Litter Company. This company quarries and crushes the dolomite and processes it for use in paint. The plant can easily be reconverted to the original use.

The location at Wingdale was close to a known source of high-purity dolomite—the quarry formerly operated by the Dover White Marble Company. The exact age of the marbles bordering the Hudson highlands is not known, but it is certainly pre-Silurian. An analysis of the marble at a nearby quarry gives MgO=20.25 per cent. This may be compared with pure dolomite in which the theoretical content of MgO is 21.70 per cent. Other marbles in the Hudson Highlands give analyses equally high in magnesia.

In the Pidgeon process, dolomite is calcined at about 1900° C to drive off the carbon dioxide. It is then mixed with precrushed ferro-silicon and briquetted. The briquets are loaded into a reducing furnace and heated under vacuum at 1150° C. After about 8 hours of firing, most of the vaporized magnesium has condensed in cooler Nichrome retorts and is removed.

Other possible sources of high-purity dolomite are in the Precambrian marbles of St Lawrence county and in the belt of Lockport dolomite which is exposed in beds thick enough to be quarried from the Niagara river eastward through Wayne county. Dolomite, in order to be of satisfactory quality to serve as an ore of magnesium, should contain more than 97 per cent total carbonates and more than 20 per cent MgO (magnesia) or 42 per cent magnesium carbonate. It should not exceed 2 per cent silica or 0.06 per cent alkalies.

MILLSTONES

Although once an important industry in certain sections of Ulster county, the production of millstones, while still active, is operating on a much reduced scale. Near the close of the last century the value of the annual millstone production was in excess of $100,000. In the period between 1904 and 1929, the annual value of millstones ranged from approximately $10,000 to $27,000. During recent years, however, annual production has fallen to less than $7,000.

Millstones are quarried from Shawangunk grit, a light gray quartz conglomerate found along the western face of Shawangunk mountain. The grit, or conglomerate, is composed of quartz pebbles of milky white color surrounded by a siliceous matrix. The pebbles are subangular in form and vary from a fraction of an inch to two inches in diameter.

The localities at or near which millstones have been quarried include Kyserike, Rosendale, High Falls, Saint Josen, Alligerville, Accord, Kerhonkson and Wawarsing. In addition, New Paltz and Kingston have been identified with the industry as shipping centers. The New York stone is known as Esopus stone, the name Esopus being an early Dutch name for Kingston. Shipment of millstones from the district was made by the Delaware and Hudson canal and, after its abandonment, by the Ontario and Western railroad. In recent years Accord has been the main shipping center by rail.

The quarry operations for millstones are carried on with a minimum of mechanical equipment, as the small output does not justify expensive quarry machinery. The layer or layers of rock are uncovered and the size of the block to be removed is dependent on the spacing of the natural joint planes. So far as possible, blasting is avoided, but if used, light charges of powder are employed to assist in separating the layers of rock. Once removed, the block is roughly squared up and then shaped into a disc by means of hand tools. The eye, or center hole, of the millstone is usually made by drilling a hole at the center of the disc. Half way through, the stone is turned over and a second hole is begun at the center of the reverse side to meet the first. The round hole thus formed may be squared to take a square shaft. The dressing, or grooving, of the millstones, the last operation in fitting them for actual use, is not done at the quarry. Millstones are usually sold in pairs, their sizes ranging from 15 to 90 inches. The greater demand has been for the smaller sizes, 24 to 48 inches in diameter. At one time there was a market for very small stones only a few inches in diameter. These were mainly for use in hand-driven spice mills.

In addition to the common type of millstone, disks are made for use in the roll type of crusher known as a chaser. Chasers are stones dressed to run on edge and horizontal shafts. They run on pans often paved with the same material as the rolling disk. Mineral paints, quartz, feldspar and barite are commonly crushed or ground by chasers.

The decline in the market for millstones was caused by the introduction of rolls, ball mills and other improved types of grinding machinery. The roller process has replaced the old millstone method, particularly in grinding wheat. Some of the small corn and mustard mills in the South still employ millstones for grinding. There is also a small demand for millstones for use in gypsum and talc mills.

Although it is not likely that the millstone industry will ever recover its former importance, the Shawangunk conglomerate, the source of the millstones, has proved to be an attractive and high-grade building stone. Its hardness alone, which has made quarrying somewhat difficult, has restricted the more general use of this stone for building purposes.

MINERAL PAINT

The production of natural mineral materials for use as pigment for low-priced paints has been a small but long-lived industry in New York State. These mineral pigments may be used alone or mixed with synthetic pigments, such as cadmium yellow, chrome green and cobalt blue. The raw material is washed and ground to the desired fineness and in some cases is calcined in order to alter the color.

All New York State mineral pigments except talc, which is white, contain a large percentage of iron oxide so that the colors of the pigments are limited to various shades of brown, red and yellow.

The Clinton hematite from Oneida and Wayne counties has been the most important source of pigment in the State. In Wayne county the ore is fossiliferous and quite high in lime and magnesia, while in Oneida county oolitic ore, rich in silica is more common. Both siliceous and carbonate ores have been ground for pigment. The Clinton Metallic Paint Company of Clinton is one of the oldest producers in the State. Red ore for use in metallic paint has been mined and shipped by the Fruitland Iron Ore Company at Fruitland.

The Antwerp-Keene hematite belt in St Lawrence and Jefferson counties has been a minor source of metallic paint pigment. Work is now limited to occasional picking of dump material. The ore is usually too hard for paint, but some parts of the deposit yield soft hematite of good color and quality. It is washed and ground at Ogdensburg, St Lawrence county.

Limonite and siderite ores occur in quantity in southeastern New York, especially in Dutchess and Columbia counties. They have not been used for paint pigment for some time. Limonite gives a brownish yellow color; the siderite a red which is brought out by calcination and differs somewhat from the red of the natural hematite.

The most recent development in the State is the exploitation of the titaniferous magnetite deposits near Lake Sanford, Essex county, by the National Lead Company. These deposits contain ilmenite from which titanium oxide can be prepared. The ilmenite concentrate is shipped to various processing plants outside the State. Titanium oxide is a white material of great covering power and is by far the most satisfactory pigment now used in good quality white paint.

Some slates and shales are suitable for grinding for pigment. They contain varying percentages of iron oxide and yield a wide variety of tints—purple, bluish-gray, red-brown and black.

The Cambrian red slate of Washington county contains finely divided hematite and occurs in almost limitless quantity. Red shales of Upper Devonian age have been worked at Roxbury, Delaware county, and red, brown and bluish shales of the same age near Randolph, Cattaraugus county, have been of some importance. The Silurian Vernon shales of Herkimer county are another source of red pigment.

Minor occurrences of ochre and sienna have been noted in Warren, Washington, Columbia and Dutchess counties.

NATURAL GAS

In 1930 the discovery of commercial quantities of natural gas in the Oriskany sandstone of Schuyler county, thereafter known as the Wayne-Dundee field, was followed by an intensive search for new supplies of natural gas from the Oriskany in other areas, and from some of the formations below the Oriskany as well.

Among the larger Oriskany fields discovered since that year are the following:

The Greenwood field, located in the town of Greenwood, Steuben county, was discovered in 1932. Out of the 12 wells drilled up to 1938, seven were producers, one with an estimated daily flow of 50 million cubic feet of gas. Of the remaining 20 wells drilled from 1938 to 1948 inclusive, there were only two producers. The first of these, drilled in 1940, had an initial daily capacity of 5,500,000 cubic feet of gas; the second, the Lewis Weber No. 3, was drilled as a storage well in 1948, not far from two early producers. At completion this well had a daily flow of 1,759,000 cubic feet of gas and a rock pressure of 930 pounds. When the pressure is sufficiently reduced, the well will be used for storage purposes.

The first well on the New York side of the State Line field was drilled in 1934. This proved to be one of the larger Oriskany fields with original reserves estimated at 45 billion cubic feet of gas, maximum development being attained about 1937. The field has now been developed for the underground storage of gas.

The Woodhull field in Steuben county was discovered in 1937. Up to the end of 1948 the number of wells drilled was 55, of which 47 produced gas. Each of about 20 of the Woodhull wells had an initial capacity in excess of 10 million cubic feet daily, the largest being 28 million cubic feet.

The Beech Hill gas field is in the town of Willing, Allegany county, about four miles northeast of the State Line pool. The first well was drilled in 1937 and in the following year 11 wells were completed, of which seven were producers. By the end of 1946 the number of wells drilled in the field was 30, of which 15 were listed as producers. The combined initial daily capacity of the 15 producers was 143,050,000 cubic feet of gas. In the Independence-Andover extension of the Beech Hill pool, several good producers have been drilled in recent years. One of the first wells, located on the Sam Crandall farm, blew wild for three weeks. It had an estimated initial open flow of 44,000,000 cubic feet of gas daily. When finally brought under control, the daily flow had been reduced to 1,500,000 cubic feet.

One of the last Oriskany gas fields to be discovered in the State was the Tuscarora, so named from the township in Steuben county in which it was located. The field lies but a short distance east of the Woodhull gas field and the first well was drilled in 1944. By April 1946 the number had been increased to 19, of which ten were producers with a total combined initial capacity of 78,066,000 cubic feet of gas daily. This field is now being used for the underground storage of gas.

Since the discovery of the Tuscarora gas field, explorations and tests have continued in various sections of the State, but they have met with little success and no new gas fields have been discovered.

In the following table, the production and value of natural gas is given for the period 1935 to 1948 inclusive:

Production of natural gas in New York, 1935–48

YEAR	PRODUCTION IN 1000 CUBIC FEET	VALUE	PRICE CENTS PER 1000 CUBIC FEET
1935	8 288 000	$5 909 000	71.3
1936	12 431 000	8 645 000	69.5
1937	21 325 000	12 388 000	58.1
1938	39 402 000	19 419 000	49.3
1939	29 222 000	15 201 000	52.0
1940	12 187 000	8 246 000	67.7
1941	10 456 000	7 853 000	75.1
1942	8 718 000	6 498 000	74.5
1943	8 062 000	5 994 000	74.3
1944	7 052 000	5 164 000	73.2
1945	9 210 000	5 919 000	64.3
1946	5 084 000	3 461 000	68.1
1947	4 776 000	3 535 000	74.0
1948	4 705 000	3 482 000	74.0

A summary of the results of drilling operations to the Oriskany sandstone, giving number of wells drilled and total initial capacity of the wells for the 1936-48 period, is shown in the accompanying table:

Summary of wells, mostly Oriskany, drilled during the 1936–48 period

YEAR	TOTAL WELLS DRILLED	NUMBER OF PRODUCERS	INITIAL DAILY CAPACITY 12,000 M. CU. FT. OR OVER	BETWEEN 6,500 M. AND 12,000 M.	BETWEEN 1,000 M. AND 6,500 M.	BELOW 1,000 M.	TOTAL INITIAL DAILY CAPACITY M. CU. FT.
1936	43	23	10	3	3	7	293 000
1937	41	28	17	5	3	3	403 418
1938	42	32	6	9	12	5	239 000
1939	56	18	4	3	10	1	104 778
1940	53	20	2	7	6	5	100 910
1941	42	18	3	2	8	5	91 031
1942	26	7	..	..	1	6	3 764
1943	26	2	..	..	2	..	3 500
1944	19	1	..	1	..	..	9 000
1945	20	7	2	3	2	..	67 139
1946	22	3	..	..	3	..	9 927
1947	20	6	1	..	3	2	23 910
1948	21	5	..	..	..	..	7 549*a*

a Production from five storage wells, only a part of which can be considered original gas.

WELLS TO TEST LOWER PALEOZOIC FORMATIONS

In addition to the wells that have been completed with the Oriskany sandstone as their objective, a number of wells have been drilled in recent years to test Paleozoic formations underlying the thick Devonian sediments. These wells included the deepening of the Herrington, the discovery well in the Woodhull Oriskany sandstone gas field of Steuben county. The original depth of the well was 3957 feet, but in 1944 it was continued to a final depth of 8625 feet, the deepest well ever drilled in New York State. No gas in commercial amounts was found below the Oriskany sandstone.

In the town of Erwin, Steuben county, a well was drilled on the Ellen Collins farm in 1940. The Oriskany sandstone was found at 3802 feet and drilling continued to a total depth of 6825 feet. The well was unsuccessful.

In the town of Arcade, Wyoming county, the K. R. Wilson well was completed in 1946. The well reached a total depth of 7144 feet and penetrated a considerable thickness of Cambrian strata. Only small flows of gas were found.

While this report has been in preparation, two deep tests have been completed (1949). One of these wells was located in the town of Van Etten, Chemung county, on the F. C. Kesselring farm. The well was drilled to a depth of 6565 feet, but only small quantities of gas were found. The second test was in the town of Columbus, Chenango county, on the Clarence Lobdell farm, and is the most easterly of the recent deep tests. The well was reported as a dry hole at a depth of 5643 feet.

PAST PRODUCTION AND FUTURE OUTLOOK FOR NATURAL GAS IN NEW YORK STATE

Previous to the discovery of gas in the Oriskany sandstone in 1930, the bulk of natural gas production in New York State came partly from the Medina sandstone of western New York, which is of Silurian age, and to a lesser extent from the relatively shallow wells in the Devonian rocks of southwestern New York, which include the oil-producing sands of Cattaraugus, Allegany and Steuben counties. In addition, the Trenton limestone of Ordovician age contributed substantial quantities to the annual production from fields lying near the east end of Lake Ontario.

For many years before the discovery of Oriskany gas, the production for the State as a whole averaged about seven billion cubic feet yearly. The increase in annual production, due to new supplies from the Oriskany sandstone, first became evident in the 1935 total when New York's gas production rose to over eight billion cubic feet. Following the discovery of Oriskany gas in the Greenwood, State Line, Woodhull and Beech Hill fields, the annual yield increased rapidly until, in 1938, the state total reached a maximum of 39 billion cubic feet. Since that time, with the gradual exhaustion of the fields and failure to find new pools, production has declined, totaling less than five billion cubic feet in 1948, which is considerably less than the average production before the discovery of gas in the Oriskany sandstone. A temporary upswing in production in 1945 is due to a new supply from the relatively small Tuscarora gas field, discovered in the Oriskany sandstone of Steuben county in 1944. The present annual yield represents not only the effect of the marked decrease in Oriskany gas, but also the gradual falling off in the older gas fields—the Medina, Trenton and the older Devonian wells.

PULASKI AND CAMDEN FIELDS ABANDONED

One of the oldest producing gas fields in the State was abandoned during 1947—the Pulaski field, located along the east border of Lake Ontario. This field, deriving its gas from the Trenton limestone and consisting of 76 wells, was first opened in 1893. The small Trenton gas field, opened at Camden, Oneida county, in 1934, was also abandoned in 1947. Eighteen wells were drilled in the Camden field, of which 13 were listed as producers. The Camden area was selected as a favorable drilling location owing to the fact that the old Davies well, drilled at Camden some 40 years earlier, frequently discharged considerable quantities of gas through the water in the casing.

HISTORICAL REVIEW OF THE GAS INDUSTRY

New York's natural gas industry dates back to the year 1821 when the first gas well was drilled at Fredonia, Chautauqua county, and to 1825 during Lafayette's visit to that village, on which occasion the local hotel was lighted by gas. Since those early years production has been continuous, but the industry did not attain more than local importance until after 1865—the year of the discovery of oil and gas by drilling in Cattaraugus county, following which supplies exceeded local requirements. About 1880, with the discovery of oil in Allegany county, additional production became available. Unfortunately, as is well known, much of the gas produced in the early development of the New York oil fields was wasted.

No statistics are available on the production and value of natural gas in New York from 1821 to 1885. Most of the gas produced was in the oil fields, of which only a small quantity was used for field, commercial or industrial use. Records of local gas production begin with the year 1885. In the period from 1885 to 1904, the Mineral Resources of the United States records the value of natural gas produced in New York as $5,799,559. No quantities are given, since, in the early days, the method of estimating the natural gas output was by computing the value of the coal which it displaced. In view of the price at which natural gas was sold from 1884 to 1904, the New York State marketed production for the period is estimated at 38 billion cubic feet with a value, also estimated, of $5,700,000. In the period from 1904 to 1948 inclusive, production of natural gas in New York amounted to 383,129,000,000 cubic feet, valued at $211,358,126. The value of the natural gas is computed at points of consumption, and for the most part, at the city gates before distribution through the city gas mains to individual consumers.

The known reserves, or "gas in sight," in New York are not large. The committees of the American Petroleum Institute and the American Gas Association place the proved natural gas reserves in New York, as of December 31, 1948, at 67,615,000,000 cubic feet. It is evident that unless new and important supplies of natural gas are discovered, the annual state production will continue to decline. With the favorable market conditions that exist in New York, it is certain that any new discoveries would be subject to rapid development and utilization.

SUPPLEMENTARY SUPPLIES OF GAS

To supplement local gas supplies, New York has long been an importer of natural gas from other states. Previous to 1887, a gas pipe line, 85 miles long, had been constructed from McKean county, Pennsylvania, to Buffalo, and gas was distributed throughout the city at 20 cents a thousand cubic feet. For many years the imports of natural gas were from Pennsylvania, but recent pipe line construction has made it possible to receive gas from states as far away as Texas. The indications are that natural gas from other states will be brought into New York in constantly increasing amounts during the next few years. At present, importations far exceed local production. In 1946, according to the United States Bureau of Mines, the natural gas distributed in the State was obtained from the following sources:

State	*Cubic feet*
New York	5 084 000 000
Pennsylvania	18 702 000 000
West Virginia	6 150 000 000
Kentucky	360 000 000
Texas	3 761 000 000
Total cubic feet available	34 057 000 000

The disposition of the foregoing quantities of gas was as follows:

	Cubic feet
Domestic consumers	22 494 000 000
Commercial consumers	4 433 000 000
Industrial uses	5 715 000 000
Refining fuel	176 000 000
Field uses	74 000 000
Exported to Canada	20 000 000
Exported to Pennsylvania	1 145 000 000
Total	34 057 000 000

The cost, or value, of natural gas in New York according to origin per 1000 cubic feet was as follows in 1947:

	Cents
Gas from gas wells	24.17
Gas from oil wells	43.33
Purchased from producers	29.08

At points of distribution, the prices were:

Domestic consumption	79.48
Commercial uses	72.63
Industrial uses	56.49
Fuel in the field	25.35

Comparison of production and consumption of natural gas in New York, 1930–1947

YEAR	PRODUCTION IN MILLION CUBIC FEET	IMPORTS IN MILLION CUBIC FEET	EXPORTS IN MILLION CUBIC FEET	TOTAL CONSUMPTION IN MILLION CUBIC FEET	DOMESTIC AND COMMERCIAL CONSUMPTION IN MILLION CUBIC FEET	INDUSTRIAL PLANT CONSUMPTION IN MILLION CUBIC FEET	FIELD CONSUMPTION IN MILLION CUBIC FEET	NUMBER CONSUMERS (DOMESTIC)
1930	9 624	9 474	107	18 991	16 915	1 577	499	273 140
1931	7 868	9 126	38	16 956	15 437	1 264	255	273 870
1932	8 813	7 957	46	16 724	15 122	1 358	244	345 070
1933	6 865	13 077	30	19 912	15 311	3 963	638	343 000
1934	6 278	24 957	26	31 209	15 899	15 032	278	338 120
1935	8 288	28 531	1 114	35 705	16 151	19 432	122	364 970
1936	12 431	31 075	2 868	40 638	17 060	23 456	122	369 690
1937	21 325	38 709	9 954	50 080	17 299	32 513	268	395 130
1938	39 402	30 932	22 384	47 950	17 696	30 017	237	398 460
1939	29 222	29 610	11 955	46 877	18 357	28 265	255	402 160
1940	12 187	17 436	2 373	27 250	20 260	6 544	446	410 730
1941	10 456	16 913	1 985	25 384	19 235	5 825	324	424 200
1942	8 718	19 277	845	27 150	20 627	6 523	252	429 670
1943	8 062	20 450	725	27 787	21 353	6 218	216	418 000
1944	7 052	20 640	635	27 057	17 625	5 528	29	429 440
1945	9 210	23 999	3 632	29 577	23 836	5 643	98	437 180
1946	5 084	28 973	1 165	32 892	26 927	5 891	74	570 475
1947	4 776	36 950	154	41 572	35 155	6 275	142	580 000

GAS TRANSMISSION LINES

For some years past New York State has had important natural gas transmission lines supplying gas to Buffalo at the west and nearly as far as New York City on the east. New facilities for natural gas transmission in New York State that are planned, under way or recently completed, are the following:

Tennessee Gas Transmission Co. This company plans a 790-mile, 20 to 26-inch pipe line from Kentucky to Boston, Massachusetts, including a 359-mile line to Buffalo. This line can also be made to serve the area between Buffalo and Albany.

The Transcontinental Gas Pipe Line Corporation plans an 1840-mile, 26-inch pipe line from Rio Grande Valley, Texas, to New York City and Brooklyn. Recent reports are to the effect that natural gas is now being supplied to certain sections on Long Island.

The Manufacturers Light and Heat Company has completed a 14-inch line from Coatesville, Pa., to Port Jervis, New York.

Home Gas Co. Wholly within the State, the Home Gas Co. has completed a 30-mile, 12-inch pipe line from Hancock to Cohecton and a 25-mile, 10-inch line from Horseheads to Dundee. The same company also plans to build ten miles of four to 12-inch field storage lines in the Dundee section of the Wayne-Dundee gas field. The Home Gas Co. has also completed a five-mile, 14-inch pipe line from Port Jervis to Deer Park.

Iroquois Gas Corporation. In the western section of the State, the Iroquois Corporation is planning to construct 13 miles of 22-inch lines to serve as loops in their pipe line system.

NATURAL GASOLINE

The extraction of gasoline from natural gas is an industry developed in the present century. Between 1905 and 1908 in Pennsylvania and at Bolivar, experimental work proved highly successful, and shortly thereafter plants were erected. In New York the first commercial production was reported in 1911 by the Bolivar Gasoline Company, whose plant had been established a year or two previously.

The success of the natural gasoline industry is dependent on available supplies of natural gas containing gasoline vapor in sufficient quantities to make its extraction profitable. Natural gas from oil wells usually contains a considerable quantity of gasoline, and such gas is termed "wet gas." When the percentage of gasoline vapor in the gas is small, it is known as a "dry" gas. In New York, the amount of natural gas treated for gasoline in proportion to production is very small—less than one per cent, whereas for the United States as a whole considerably more than one-half the production of gas is so treated. This small percentage for New York results partly from the fact that much of the gas is relatively dry and produced in scattered districts outside the oil pools, and from the further fact that the amount of gas from old oil wells within the pools is small and a considerable percentage of it is consumed on the leases.

The yield of gasoline from 1000 cubic feet of gas varies considerably, the average for the United States as a whole being a little more than a gallon. In New York the yield per 1000 cubic feet of gas has been about two and one-half gallons. In some of the earlier years, when more plants were in operation, the output was at times as low as three-fourths gallon per 1000 cubic feet of gas.

Different processes are employed in the extraction of gasoline from natural gas. For relatively dry gases the absorption method is the one most generally employed, for wet gases the compression method is widely used. Both methods have been in use in New York, but at present the only plant operating uses the compression method. A method more recently developed, known as the charcoal process, has not been employed in this State.

Gasoline produced from natural gas is known as "raw," or "unblended," gasoline. The term "casing-head" gasoline also is applied to this product when derived from the casing-head gas of oil wells. The drip gasoline of the gas pipe lines is likewise a natural gasoline. Raw gasoline as it is extracted from natural gas is highly volatile and, before being marketed as a motor fuel, it is blended with naphtha or other distillate forming a high-grade commercial gasoline. Of the total amount of gasoline produced in the United States about 12 per cent is derived from natural gas, the remainder being obtained from crude petroleum. Gasoline obtained from petroleum by ordinary distillation is known as "straight run" gasoline; that obtained by decomposition of heavy petroleum fractions is known as "cracked" gasoline.

The natural gasoline industry in New York, never of great importance, has declined rapidly during recent years. Since 1933 production has fallen below 100,000 gallons annually. The maximum production reported was in 1926 when the volume was 539,000 gallons. During the period of flush production five or six companies were in operation, but more recently activities have been confined to a single company.

In the accompanying table, quantities and values are shown for the raw, or unblended, gasoline, and not for the blended product which, both in quantity and value, greatly exceeds the data in the table.

Production of natural gasoline in New York, 1937–48 [1]

YEAR	GALLONS	VALUE
1937	32 953	$2 366
1938	27 320	1 541
1939	34 000	800
1940	17 000	1 000
1941	17 000	1 000
1942	15 000	1 000
1943	14 000	1 000
1944	12 000	1 000
1945	8 000	500
1946	8 000	500
1947	10 000	1 000
1948	11 000	1 000

[1] Statistics of production of natural gasoline for the earlier years beginning with 1918 are contained in Museum bulletins numbers 277 and 319.

PEAT

Deposits of peat are rather widespread in New York State. The swamp lands in which the peat occurs have been estimated at 1,600,000 acres, or about five per cent of the area of the State. While most of the swamp areas contain peat, no detailed survey has been made of the many peat deposits, nor has the thickness been determined except in a few of the more important areas.

The number of swamp deposits in the State is very large and it has been stated that it would be difficult to find a spot in the entire State that is more than ten miles from a swamp. One of the important peat swamps is that of the Drowned lands in Orange county. The lands once covered 17,000 acres, of which a good part has been drained and converted to agricultural use. In recent years some new drainage projects have been undertaken with a view to extending the drained areas further.

In the Drowned lands, a number of measurements of the thickness of the peat away from the margin varied from 12½ feet to 18 feet, with the bottom not reached in some of the deeper measurements. Another peat locality in Orange county is the 3000-acre tract between Chester and Greycourt. Much of this has been converted to agricultural purposes. On the east side of the Hudson, a number of peat deposits occur in Putnam and Westchester counties. Putnam county has contributed to peat production in recent years. Other counties in the Metropolitan area contain peat deposits, but because of building developments, most of them are no longer available. One or two localities on Long Island produce peat for use chiefly in agriculture.

In northern New York, in and around the border of the Adirondacks, are several hundred ponds, lakes and swamps that contain peat in varying quantities. One extensive area is found along the Barge canal in the town of Kingsbury, Washington county. There are also a number of peat deposits in the Hudson valley in the vicinity of Glens Falls and Fort Edward. A plant for utilizing peat was erected some 70 years ago at the Rosecrans swamp northeast of Glens Falls. A second plant for working peat was erected on the Lake George road between Glens Falls and French mountain. Neither of the plants ever had a large output and neither survived long.

Numerous streams on the west side of the Adirondacks have their headwaters in swamps and the waters of the streams are often colored by the organic material of peaty deposits. Among these rivers are the Black, Oswegatchie, Indian and Grasse. A number of years ago the International Fuel and Power Company erected a plant for dredging peat from Black lake, which is really an expanded part of the Oswegatchie river. The plant, erected at a reported cost of about $200,000, consisted of a self-propelling barge, which in addition to the dredge, contained machinery for artificially drying and shaping the peat into briquets. A market for the briquets had been obtained at Ogdensburg, but in 1907 a fire destroyed the plant before it was put in operation, and the project was abandoned.

In central and western New York there are extensive swamp and peat deposits. One area near Rome consists of several thousand acres. At the time of the building of the Barge canal, a considerable part of this area was drained and put under cultivation. It is reported that the peat and muck beds have a thickness up to 40 feet. A factory to convert peat into fuel was erected near Rome many years ago, but the plant closed down after a brief period of operation. Only a few miles west of the Rome area are the Cowaselon and Cicero swamps. These lie south of Oneida lake and extend for about 25 miles in an east-west direction with a width of about two miles. The Cowaselon, or eastern swamp, has been mostly drained by the Douglas ditch and has provided excellent land for growing onions. North of Cayuga lake are the Montezuma marshes, eight miles long and two to three miles wide, the northern margin of which has been drained and used for agricultural purposes. The marshes are intersected by the Seneca and Clyde rivers which, in time of flood, deposit varying quantities of silt and thus impair the quality of the peat.

Three of the larger swamps in western New York are the Oak Orchard swamp of 25,000 acres in Genesee and Orleans counties, Tonawanda swamp consisting of 20,000 acres and extending east from Tonawanda and the Conewango swamp of 12,000 acres partially on the border between Cattaraugus and Chautauqua counties. A State drainage ditch has served to drain a part of the Conewango swamp and a considerable area of the Oak Orchard swamp has been developed for agricultural purposes. No detailed studies have been made to determine thickness and quality of the peat in the three western New York swamps.

Uses of peat. Although peat deposits in the State have been worked in a small way at various times and places for more than 125 years, the mining of peat for fuel has never become a successful industry. In its natural condition peat is not a fuel, since, as it comes from the bed, it may carry as much as 90 per cent water. In other words 100 pounds of wet peat will yield only 10 pounds of water-free material. To expel all the water is an expensive operation, and to do so with artificial heat entails a consumption of heat units that may nearly equal, or be in excess of the heating value of the dried peat recovered. Consequently most of the drying must be carried out by natural means—that is, by air-drying, the method employed in the peat bogs of Ireland and Sweden. As a result of air-drying the moisture content may be reduced to 25 or 30 per cent. The remaining moisture is probably held in chemical combination with the cellulose. Air-dried peat with a moisture content of 25 to 30 per cent has about one-half the heating value of a good commercial coal.

A number of years ago a company was organized to develop the peat beds near Oswego. The intent of the company was to manufacture a coarse paper from the peat. Samples of peat from Oswego were tested at a Michigan plant and found to be satisfactory for the making of paper, but the Oswego project never reached the production stage.

Another field for the employment of peat is in connection with the gas-producer for power plants, whereby the recovery of the nitrogen content in the form of ammonium sulphate becomes practicable. The gas, produced by the combustion of the peat after the removal of the nitrogen compounds, is used for fuel. Experiments with this process have been tried in New York.

Practically all the peat produced in New York in recent years has been for use in the agricultural field. The various types produced include moss peat, reed, or sedge peat and peat humus. Most of the peat is used directly on soils or in mixture with chemical fertilizers. A limited amount is used for packing purposes, especially in nurseries. The production of peat in New York for the 1937 to 1942 period is given in the following table. After 1942 permission has not been obtained 'to published production from the two active operators.

Production of peat for the 1937 to 1942 period

YEAR	TONS	VALUE
1937	10 928	$23 788
1938	14 131	79 297
1939	18 306	116 875
1940	19 352	148 433
1941	13 905	105 120
1942	9 000	41 000

PETROLEUM

During 1948, as for many years past, drilling operations for oil in New York have been confined almost exclusively to the secondary-recovery areas of the 70-year-old oil fields in Allegany, Steuben and Cattaraugus counties. Production of oil in New York in 1948 amounted to 4,621,000 barrels, which represents a decrease of 141,000 barrels, or nearly three per cent below the 1947 production. In the twelve-year period covered by this report, 1937–48 inclusive, the average annual production of oil has been slightly less than 5,000,000 barrels. In six of the 12 years, annual production exceeded 5,000,000 barrels. The 1937 output of 5,478,000 barrels was the largest since the flush period from 1882 to 1885, shortly after the discovery of oil in Allegany county.

From the flush production of oil in the early eighties, the annual yield of the oil fields gradually declined, and the year 1912 marked an all-time low with a production of only 782,000 barrels. Since no new fields were being discovered, it seemed that the end of life for the New York oil fields was close at hand. Fortunately for New York producers, the flooding of oil sands by water to increase production was introduced and proved to be successful, thus giving a new lease of life to the New York fields.

Although the principle of increasing oil by water-flooding of the sands had been known for many years and a few floods had been established, some of them accidentally, others secretly, it was not until about 1919 that a definite upward trend in oil production was recorded. In 1919 the use of water-flooding methods to increase oil production was approved by legislative action and by 1922 the annual crude production had again reached 1,000,000 barrels. Since that time, there has been a fairly steady increase in production to more than 5,000,000 barrels annually with only a moderate decline during the last few years. In the accompanying table the production and value of petroleum is given for the years 1919 to 1948 inclusive:

Production of petroleum in New York since flooding of oil fields became legal in 1919, through 1948

YEAR	BARRELS (42 GALLONS)	VALUE
1919	851 000	$3 100 000
1920	906 000	5 433 000
1921	988 000	3 262 000
1922	1 000 000	3 144 000
1923	1 250 000	4 140 000
1924	1 440 000	5 245 000
1925	1 695 000	6 270 000
1926	1 956 000	7 300 000
1927	2 242 000	7 110 000
1928	2 603 000	8 750 000
1929	3 377 000	13 170 000
1930	3 647 000	9 850 000
1931	3 363 000	6 800 000
1932	3 508 000	6 630 000
1933	3 181 000	5 960 000
1934	3 804 000	9 340 000
1935	4 236 000	9 080 000
1936	4 663 000	11 380 000
1937	5 478 000	14 140 000
1938	5 045 000	9 550 000
1939	5 098 000	10 650 000
1940	4 999 000	11 600 000
1941	5 185 000	13 300 000
1942	5 421 000	16 000 000
1943	5 059 000	15 230 000
1944	4 697 000	15 640 000
1945	4 648 000	17 470 000
1946	4 863 000	18 630 000
1947	4 762 000	20 050 000
1948	4 621 000	22 975 000

The New York oil fields may be considered as the extreme northeast extension of the Appalachian oil fields. They form two distinct areas: one in Cattaraugus county—the direct northern extension of the Bradford pool of Pennsylvania; the other to the east in the adjoining county of Allegany. East of Allegany county, there is one small pool in the county of Steuben. For convenience, and partly from necessity, the Cattaraugus county pools are often included in the Bradford district, whereas the important Richburg, or Bolivar, and other pools of Allegany county and of Steuben county as well, constitute the Allegany district. In volume of production, the output of the Allegany fields greatly exceeds that of the Cattaraugus and it is from the Allegany district that the major amount of future production of oil can be expected.

In 1948 local pipe line runs, which do not include oil transported by trucks or used for field consumption, credit the New York portion of the Bradford district (Cattaraugus county) with a production of 851,000 barrels and the Allegany field with 3,550,808 barrels. For the State as a whole the 1948 decrease of 141,000 barrels as compared with the 1947 production is due to a lowered output in Cattaraugus county, where, for the second time in ten years, annual production has fallen below the one million barrel mark. In the Allegany field, on the other hand, production has been well maintained and there was an actual increase in the amount of oil produced as compared with 1947. In the following table the production of oil, based on pipe line runs, is given for the 1939-48 period for the Allegany and the Cattaraugus fields:

Production of oil on basis of pipe line runs, 1939–48

YEAR	ALLEGANY FIELD (BARRELS)	CATTARAUGUS FIELD (BARRELS)
1939	3 402 530	1 694 695
1940	3 452 535	1 546 505
1941	3 739 425	1 445 675
1942	4 003 685	1 418 390
1943	3 790 525	1 238 445
1944	3 614 065	1 081 530
1945	3 491 404	962 606
1946	3 618 822	1 006 560
1947	3 490 082	1 017 730
1948	3 550 808	851 965

OIL RESERVES

From the opening of the New York oil fields in the late seventies to 1948 inclusive, the State has produced approximately 168,586,000 barrels of oil. The close of 1948 marked the 30th year of oil production since flooding became legal in 1919. In the 40 years or more previous to 1919 during which the oil fields had been worked, oil production in the State amounted to 64,000,000 barrels. During the 30-year period since 1919 oil production obtained principally by the secondary method of flooding has totaled 104,586,000 barrels. Production for each of the ten-year periods since 1919 has been as follows: 1919-28 period, 14,931,000 barrels; 1929-38 period, 40,302,000 barrels; 1939-48 period, 49,353,000 barrels.

The total number of acres in New York that have produced some oil has been estimated at about 95,000. During the 30-year period 1919 to 1948, 28,200 acres have been developed for secondary recovery of oil by the flooding method; 32,800 acres of favorable oil territory remain to be developed, and 34,000 acres, mostly in Cattaraugus county, are regarded as unfavorable for economic development by the secondary-recovery methods now in use in the New York fields. From the oil areas already producing by secondary-recovery methods plus the 32,800 acres yet to be developed, it is estimated there will be a total recovery of 71,500,000 barrels. In the making of this estimate, consideration was given to (a) recent improvements in methods used in secondary production; (b) character of sands with respect to porosity, permeability and saturation; (c) the amount of oil still to be recovered from sands already under flood; (d) additional oil from deeper sands in areas already under flood; (e) additional recovery of trapped oil in old floods where original pressure wells were drilled too far apart. Other factors of importance in arriving at this estimate included well-spacing, selective well-shooting, water pressure and character of water used. It was recognized, too, that in the undeveloped areas the oil sands on the average will be thinner than those in the developed areas. An unpredictable factor—the price of oil—will also have an influence in determining the length of time a well will be pumped and thus affect the ultimate total production. For example, a December 1948 cut in the posted price for oil will undoubtedly curtail drilling operations during 1949. One other factor—the increase in imports of crude oil in recent months—is being viewed with alarm by many producers and if continued at a high rate is bound to affect the price of local oil adversely.

In the past the average production per acre from flood operations has been approximately 3500 barrels. If the undeveloped areas, with admittedly thinner sands, yield but 2000 barrels per acre, their production would total 65,600,000 barrels. This amount, added to the oil yet to be obtained from sands already under flood, may eventually result in a grand total even exceeding the present estimate of 71,500,000 barrels.

Since 1919 the number of acres put under flood annually has averaged about 916. In recent years the number has increased to an average of about 1850 acres.

The number of wells drilled in the oil fields during 1948 was 1742. Of these, 891 were oil and 851 were water-intake, or pressure, wells. In the four preceding years, the average number of wells drilled annually was a little more than 1500. The number of oil wells usually exceed the number of water wells by 30 to 40. One reason for the excess of oil wells is the drilling for trapped oil between water wells in developed flood areas. The estimated number of producing oil wells in New York State is 23,200 with an average daily production of .55 barrel.

LIFE OF THE NEW YORK OIL FIELDS

As has been stated, in the 30 years that have passed since the flooding of the oil sands became legal in 1919 about 28,000 acres have been put under flood leaving 33,000 acres favorable for flooding. This includes a greater percentage of thinner sands than in the 28,000 already under flood. It would be possible, of course, to start floods in the entire undeveloped area within a period of one or two years, but such a procedure would be uneconomical in that it would greatly shorten the life of the fields and affect local business adversely. Moreover, greatly increased local production would lower prices considerably if at any time it exceeded refinery requirements. It would therefore seem logical that some 12 to 15 years would be required to develop the unflooded areas and a comparable additional period to water out the sands. This would indicate the future life of the fields to be between 24 to 30 years.

OIL PRICES

The price paid for crude oil changes frequently and under normal conditions a half-dozen changes can be expected annually. In the 12-year period covered by this report, there have been 40 changes in the posted price for crude oil. The low price of $1.68 a barrel prevailed from September 1, 1938, to January 21st of the following year. The high price of $5.00 a barrel was in effect from December 6, 1947, to December 11, 1948, with the result that the value of the 1948 oil production reached an all-time high of nearly 23 million dollars.

BOLIVAR REFINERY ABANDONED

One of the noteworthy events in the oil industry during 1947 was the abandonment of the refinery of the Allegany Refiners at Bolivar. The closing down of this nearly new refinery was necessitated by the abandonment of the railroad that served the community. The refinery was located midway between the Sinclair refinery at Wellsville and the Socony Vacuum refinery at Olean. The Bolivar refinery was started in 1933 when local operators were unable during the depression years to dispose of their oil through any of the purchasing agencies or to any of the refineries nearby.

PYRITE

Pyrite, the sulphide of iron, is composed of 46.7 per cent iron, and 53.3 per cent sulphur. Its sulphur content is used almost entirely by the chemical industry for the manufacture of sulphuric acid.

Fortunately, during recent years there has been an abundance of pyrite and native sulphur as well, by way of contrast with their scarcity from 1914 to 1918. Previous to World War I the low price of pyrite imported from Spain and Italy had discouraged domestic competition and the pure sulphur deposits of Texas and Louisiana were then undeveloped. Consequently when imports were cut off by submarine warfare the need for sulphur became acute. At present the demand for sulphur greatly surpasses that of World War I but available domestic reserves are plentiful and at the beginning of 1941 there was a sufficient stockpile on hand to last for nearly two years.

Although sulphuric acid is indispensable in the production of explosives, the percentage of the material necessary for this purpose is relatively small. It is, however, supremely important as a war material in that it supplies the fundamental heavy chemical essential in tremendous quantities for the manufacture of acid fertilizers, for the refining of petroleum and in the pickling of steel preparatory to galvanizing. Lesser quantities are indispensable in the manufacture of rubber, in the sugar industry, in the processing of textiles, in the kraft paper industries, for the creation of chemicals, such as titanium dioxide and ammonium sulphate, and in numerous other chemical processes.

In addition to its use for sulphur content in the manufacture of sulphuric acid, pyrite is utilized in two other ways—and these of relatively minor importance—as a pigment in metallic paints and for its iron content, which after roasting of the pyrite, may be sintered and sold as an iron ore.

Before pyrite can be shipped the ore is ground fine enough to free the pyrite particles and separation from the gangue is then accomplished by well-known methods of wet concentration. The resulting concentrates are sold on analysis and prices are based on the percentage of sulphur contained, so much per unit. For example, pyrite containing 45 per cent sulphur at 13 cents a unit would sell for $5.85 a long ton. During World War I, the price at one time jumped to 30 to 33 cents per unit. In 1919 seaboard prices had fallen as low as 17 cents per unit, owing to the influx of the newly mined, pure sulphur from Texas, and in 1923 had receded further to 12 cents per unit.

The fortunes of the New York industry are reflected in the history of its pyrite mining as a whole. Several mines in St Lawrence county were in operation during World War I—among them those at Stellaville, near Hermon, last worked by the St Lawrence Pyrite Company in 1920, the Cole mine near Gouverneur operated by the New York Pyrites Company as late as 1921, and the mines at Pyrites operated at one time by the High Falls Pyrites Company and later by the National Pyrites Company. Production from strictly pyrite mines reached a peak in the years 1917-20, but the decline of the industry in the postwar years proved inevitable. Milling plants had become essential equipment at each mine involving a large investment, since the run-of-mine product was but 25 to 30 per cent sulphur content. Thus about two tons of crude were required for one ton of concentrates. The rapid development of Gulf Coast sulphur, practically 100 cent pure, had a marked shipping advantage over the bulky 50 per cent pyrite concentrates. Besides, pure sulphur had an availability for many purposes not served by pyrite. Prices fell. The competition proved too severe and the mines shut down.

The principal occurrences of pyrite in New York State are associated with the Precambrian rocks of the Adirondacks, more particularly the Grenville series of highly altered sediments. These have their main development on the northwest side of the Adirondacks in St Lawrence county where the pyrite bodies attain their maximum size and richness. The deposits consist of bands or zones of quartz, schist and felspathic gneisses impregnated with the sulphide either alone or associated with subordinate amounts of pyrrhotite. The common gangue is vitreous quartz. The bands individually range from a few feet to 50 feet or more in width and are of indefinite length. A series of such bands can be traced from Antwerp, Jefferson county, to near Canton, St Lawrence county, a distance of 40 miles.

A list of the more important pyrite mines, shafts and prospects of the St Lawrence-Jefferson County district, nearly all of which have been described or mentioned by Buddington in Bulletin No. 1 of New York State Defense Council 1917, is as follows:

Name	*Location*
Stella mines	Stellaville, about 1 mile north of Hermon.
Cole mine	Located beside railroad on farm of J. F. Cole, five miles northeast of Gouverneur.
Farr shaft	Town of DeKalb, about three miles northeast of Bigelow. About one-half mile southeast of schoolhouse, on H. Fleming farm.
Mitchell shaft	About two and two-thirds miles northeast of Bigelow, town of DeKalb, about two-thirds mile southeast of road. Located on southeast edge of a small ridge and lies just north of Indian creek, near end of Moss ridge.
Styles shaft	On farm of D. G. Styles, about one and four-fifths miles northeast of Bigelow, DeKalb township.
Hendricks shaft	Town of DeKalb, one and one-half miles southwest of Bigelow on west side of railroad where latter crosses Boland creek.
Caledonia mines	Just east of Old Iron Works in town of Rossie.
Keene ore bed	About one-third mile west of Keene's station, town of Antwerp.
Morgan ore bed	Town of Antwerp, one and one-half miles southwest of Keene's station.
Wight ore bed	Town of Antwerp, about two miles north of village of Antwerp.
Dickson ore bed	Town of Antwerp, about one and one-half miles north of Antwerp on Jefferson Iron Company's switch.
Laidlaw farm	West face of a conspicuous knoblike hill, one mile southeast of Oxbow and one-fourth mile southwest of road to Antwerp, on southwest side of creek.
Frank Bent farm	Town of Antwerp, two and one-half miles southwest of Oxbow about one-fourth mile southwest of "Pulpit Rock" road, near some old iron ore pits. Just opposite fifth farmhouse after leaving Oxbow on "Pulpit Rock" road.
Kilburn belt	Town of Fowler, about one and one-half miles west of village of Fowler and two-fifths mile south of road from Fowler to West Fowler.
Pyrites	Series of openings at Pyrites along Grass river and two prospects: one about one-fourth mile west of Pyrites and the other about one mile a little south of west of Pyrites.
Ore Bed school	Town of Hermon, about two miles southwest of village of Hermon.
Pleasant Valley school	A hill of rusty gneiss just north of Pleasant Valley school on road between Edwards and Fullerville. Veins of pyrrhotite also present.

In addition to the pyrite deposits just enumerated many other occurrences, mostly only of scientific interest, have been recorded in many sections of the State. Among the deposits that may at some future time be of commercial interest are those associated with the graphite beds of the eastern Adirondacks. Pyrite is often associated in considerable amounts with graphite and could be recovered as a by-product. When the graphite mines were active in the Lake Champlain region some pyrite was recovered from one of the mines. In southeastern New York a mine of pyrrhotite, located on Anthony's Nose near Peekskill, was formerly worked for its sulphur which was used at a local acid factory on the Hudson river. This mine, of considerable importance in its day, was last worked about 1870. In the Paleozoic sedimentary rocks, pyrite deposits are known in numerous localities. Only a few of more than a hundred reported finds are of more than scientific interest. Two of the better known deposits are in the Brayman shale of Silurian age at Schoharie and Howe's Cave. Other deposits of pyrite are known in the Devonian formations but none of them are of commercial importance.

It is an interesting commentary on the pyrite industry in New York that since 1921 the only pyrite marketed in the State has been obtained as a by-product of zinc mining at Edwards and at Balmat in St Lawrence county, a short distance to the east of the pyrite belt just described. The ores from those mines are valuable for their content of zinc blende with which the pyrite is associated in sufficient quantity to require its removal before the blende can be reduced to metallic zinc in the furnace. The pyrite recovery under these conditions proves profitable at current prices and is shipped separately to sulphuric acid manufacturers.

Since 1936 the output of pyrite in New York State has rivaled, and latterly surpassed, that of the peak year of 1918 during World War I. The 1937 production reached an all-time high of 74,834 long tons.

At present, New York is one of the four leading states in the production of pyrites, being exceeded only by Tennessee, California and Virginia. The decline in the pyrite mining industry following the year 1918, and its recovery as a by-product in zinc mining, is shown in the accompanying table. All pyrite sold since 1921, has been obtained from zinc mines.

Production of pyrite in New York, 1918–44

YEAR	LONG TONS	YEAR	LONG TONS
1918	63 982	1931	26 604
1919	60 544	1932	16 871
1920	30 753	1933	19 824
1921	32 143	1934	31 674
1922	5 900	1935	48 905
1923	11 000	1936	62 530
1924	7 593	1937	74 834
1925	12 000	1938	63 772
1926	7 635	1939	71 176
1927	*a*	1940	64 498
1928	*a*	1941	63 958
1929	*a*	1942	68 826
1930	15 474	1943	62 907
	......	1944	*b*

a None reported produced or sold.
b Not at liberty to publish after 1943.

SALT

The 1948 production in New York of 21,898,793 barrels of salt, valued at $13,056,542, marked an all-time record both as to volume and value. Since 1797 when statistics first became available with the establishment of state-owned springs at Syracuse, the growth of the salt industry in New York has gone steadily upward with only an occasional temporary decline due to depression years or other industrial conditions. From a production of 5095 barrels in 1797, the one million-barrel mark was reached in 1849, the ten million mark in 1910, the 15 million mark in 1917 and the 20 million mark in 1943. Except for the low-production years of 1921 and 1932 the annual output between 1919 and 1940 was maintained at about 13 or 14 million barrels annually until 1940 when increased demands again raised production to over 15 million barrels. Since 1943 production has exceeded 20 million barrels annually.

The unit of measurement for salt, as used in our mining and quarry reports, is expressed in the barrel of 280 pounds. In early operations for salt production in the State the unit of measurement was in bushels of 56 pounds, the equivalent of one-fifth of a barrel. This was the unit used in the many annual reports of the superintendent of the Onondaga Salt Springs Reservation in Onondaga county. With the increase in volume of production the unit of measurement is often given in short tons. A short ton is equal to seven and one-seventh barrels of 280 pounds.

In the accompanying table the production of salt is recorded for the years 1797 to 1948 inclusive. This is followed by a table giving production and value of different types of salt since 1930. For 1947 the average price received for all grades of salt—evaporated, rock or salt in brine—was 51 cents a barrel. Evaporated salt, which includes domestic and dairy salt, brought $1.51 a barrel, rock salt 55 cents a barrel and salt in brine had a nominal value of about 12 cents a barrel.

Total production of salt in New York, 1797–1948

YEAR	BARRELS
1797–1918	323 870 546
1919	13 913 064
1920	13 593 578
1921	10 392 957
1922	14 006 193
1923	14 756 014
1924	14 091 486
1925	14 671 214
1926	14 297 000
1927	14 029 143
1928	14 894 500
1929	15 675 643
1930	14 352 000
1931	12 778 143
1932	11 118 872
1933	13 197 829
1934	13 330 571
1935	13 770 157
1936	14 442 736
1937	14 891 907
1938	12 264 743
1939	14 582 086
1940	15 126 221
1941	19 425 614
1942	19 447 643
1943	20 902 771
1944	20 897 679
1945	20 444 457
1946	20 098 443
1947	20 878 736
1948	21 898 793
Total	792 040 739

Production of salt in New York, 1930–48

YEAR	EVAPORATED SALT		ROCK SALT AND SALT IN BRINE		TOTAL	
	Barrels	Value	Barrels	Value	Barrels	Value
1930	2 360 714	$3 225 003	11 991 286	$2 612 100	14 352 000	$5 837 103
1931	2 503 143	3 126 179	10 275 000	2 167 291	12 778 143	5 293 470
1932	2 430 672	3 152 722	8 688 200	1 632 629	11 118 872	4 785 351
1933	2 542 543	3 335 367	10 655 286	1 785 479	13 197 829	5 120 846
1934	2 464 007	3 345 416	10 866 564	1 917 978	13 330 571	5 263 394
1935	2 699 893	3 412 540	11 070 264	1 918 593	13 770 157	5 331 133
1936	2 758 579	3 443 644	11 684 157	2 166 288	14 442 736	5 609 932
1937	2 661 679	3 562 823	12 230 228	2 232 728	14 891 907	5 795 551
1938	2 429 550	3 378 167	9 835 193	2 088 910	12 264 743	5 467 077
1939	2 827 850	3 496 414	11 754 236	2 359 008	14 582 086	5 855 422
1940	2 657 493	3 683 490	12 468 728	2 840 285	15 126 221	6 523 775
1941	3 131 793	4 006 454	16 293 821	3 410 280	19 425 614	7 416 734
1942	3 037 257	4 355 825	16 410 386	3 802 322	19 447 643	8 158 147
1943	3 198 207	4 909 059	17 704 564	4 419 613	20 902 771	9 328 672
1944	3 429 864	5 296 840	17 467 815	4 602 740	20 897 679	9 899 580
1945	3 501 757	5 347 891	16 942 700	4 979 122	20 444 457	10 327 013
1946	3 329 393	5 025 740	16 769 050	5 127 534	20 098 443	10 153 274
1947	3 089 321	5 192 627	17 789 415	6 682 858	20 878 736	11 875 485
1948	3 070 500	5 620 727	18 828 293	7 435 815	21 898 793	13 056 542

New York is an important producer of sodium compounds, principally at Solvay, near Syracuse, and at Niagara Falls. At Solvay the salt in brine is obtained from wells driven to the rock salt beds located at Tully, 17 miles distant. The process of manufacture depends upon the interaction of ammonium bicarbonate and salt in solution, together with carbon dioxide obtained from limestone quarried at Jamesville, a few miles from Solvay. At Niagara Falls the plants use rock salt and employ electro-chemical processes in manufacture.

New York ranks second to Michigan in the value of salt produced and is followed by Ohio, Louisiana, Kansas and California. In 1947 New York contributed 18 per cent of the total output of salt in the United States; in 1942, 20 per cent.

The salt resources of New York are enormous and it is safe to say that they amount to hundreds of billions of tons. The presence of rock salt beds has been established in an east-west line from Madison county on the east into Erie county on the west, a distance of 135 miles. On the south the beds extend beyond the borders of the State. The dip of the salt formations toward the south together with the higher surface elevations of the Allegheny plateau makes their depth in excess of 4000 feet along the southern border of the State and thus unfavorable for economic development. The total area of central and southwestern New York underlain by rock salt deposits is approximately 6000 square miles. The thickness of individual beds varies from a few feet to 50 or 75 feet. Drilling records indicate that several beds may exist in a single area. In the Seneca Lake region five or six are known to be present, some of which appear to be in the form of attenuated lenses, gradually thinning out, only to be succeeded by other lenses at or near the same horizon.

The salt beds are all included in the Salina formation of the Silurian. Their position within the Salina is above the basal member known as the Vernon red shale and at or near the base of the Camillus shale which, together with the higher Bertie waterlime, form the two upper members of the Salina. Some evidence exists that one or more thin salt lenses actually occur near the top of the Vernon since, in one or two localities, red shale, assumedly Vernon, has been found above one of the lower salt beds.

The salt industry of New York has long been of commercial importance. The presence of a salt spring in the Syracuse region was first recorded by the Jesuit father, Jerome Lallemont, in the "Jesuit Relations for 1645-1646." In 1653 Father Simone LeMoyne visited the Syracuse region, made some salt and carried a sample to Quebec.

Not long after the visit of Father LeMoyne the Indians and white traders began the manufacture of salt in a small way and brought their product along with furs to Albany and other trading posts.

The importance of the Onondaga, or Syracuse, salt springs was clearly impressed upon the people of the State during the Revolution when both Long Island and the Onondaga springs were in hostile territory and salt became very scarce, selling for as much as eight dollars a bushel. Serious salt riots in several sections of the State were averted only after strenuous measures had been taken to obtain salt from outside sources. In 1788, shortly after the Revolution, the State acquired from the Indians a large tract of land that included the Onondaga salt springs. During that year it is reported a small quantity of salt was made at the springs by Comfort Tyler and Asa Danforth. In the fall of 1789 and the year following, five or six hundred bushels were manufactured by Nathaniel Loomis, which he sold for one dollar a bushel. Thereafter the number of salt manufacturers increased rapidly, and in 1797 the Legislature created the Onondaga Salt Springs Reservation, and a superintendent who had charge of all operations was appointed. For this service a tax of four cents a bushel was collected by the State. During the period from 1816 to 1834, a tax of 12½ cents was levied for the purpose of increasing the building fund of the Erie canal which passed directly through the salt district. The building of the canal proved a boon to the salt industry since it provided a low transportation rate to the Atlantic seaboard and to the ports on the Great Lakes as well.

Owing to the discovery and utilization of the rock salt deposits of the State and to competition of other states, the manufacture of salt on the Onondaga Reservation rapidly declined. The brines of the Onondaga district, weakened by one hundred years of pumping, carried only 16 or 17 per cent of saline constituents as compared with 25 per cent for the brines derived from the rock salt deposits. In 1908 the State relinquished control of the salt springs, but the manufacture of salt was continued for a number of years. The last salt made in the Onondaga district from the natural brines was by Thomas Gale in 1926 with final sales in 1927. The extensive salt sheds, once such a prominent landmark in the salt district, have all been dismantled.

Although the existence of beds of rock salt in the Salina rocks south of their outcrop in central New York was suggested in the reports of the early Geological Surveys, the actual presence of rock salt was not demonstrated until 1865. In that year rock salt was encountered in a deep well drilled at Vincent, Ontario county. Nothing came of this discovery, however, and it was not until 1878, when rock salt was discovered in a wildcat well drilled for oil at Wyoming, Wyoming county, that steps were taken to develop the rock salt deposits. In the Wyoming well, known as the Pioneer, the salt was found at a depth of nearly 1300 feet and was 70 feet thick. Tests made of the salt showed that a high-grade, fully saturated brine could be obtained. Manufacture of salt from the artificial brines was soon undertaken and in central and western New York many wells to the salt beds were drilled and evaporating plants erected. As a result of over-expansion many of the earlier salt manufacturing plants did not long survive. Among the localities that have produced salt from artificial brines are the following: Wyoming county at Warsaw (seven plants), Rock Glen, Silver Springs, Castile, Gainesville, Pearl Creek, Saltvale, Perry and Bliss; Livingston county at Cuylerville, Mount Morris and Piffard (two plants); Genesee county at Le Roy and Pavilion; Tompkins county at Myers (Ludlowville) and Ithaca; Schuyler county, two plants at Watkins Glen; Onondaga county with wells at Tully, which supply the brine through pipe line to the Solvay Process Works at Solvay. At present the only salt evaporating plants are located at Watkins Glen (two plants), Myers, Silver Springs and Solvay. With the erection of a new salt plant in view, test wells have been drilled during the last year or two into beds of rock salt at Hammondsport, Steuben county. Details of the project have not as yet been made public.

The mining of rock salt in New York was begun in 1885 upon completion of a shaft at Retsof, Livingston county, by the Retsof Mining Company. Another shaft, a short distance west of the Retsof, known as the Greigsville, was sunk by the Greigsville Salt and Mining Company. At Lehigh, two and one-half miles south of Le Roy, Genesee county, a shaft was completed by the Lehigh Mining Company. The shaft of the Livonia Salt Mining Company was located south of the village of Livonia, Livingston county. In July 1895 there was a consolidation of the four rock salt companies under the name of the Retsof Mining Company and eventually all the mines, except the one at Retsof, were closed. In 1906 the Sterling Salt Company began mining at Cuylerville and was active until 1930 when the mine was closed after the property was taken over by the Retsof Mining Company, a subsidiary of the International Salt Company. On the east side of Cayuga lake, at Portland Point, Tompkins county, a salt shaft was completed in 1917 by the Rock Salt Corporation. The shaft was deepened at a later date to obtain a better grade of salt and at present the mine is operated by the Cayuga Rock Salt Company, Inc.

The list of salt producers of New York is as follows:

NAME OF OPERATOR	POST OFFICE	LOCATION OF PLANT
	Livingston co.	
International Salt Co., Inc. *r*	Scranton Life Bldg., Scranton, Pa.	Retsof
	Onondaga co.	
The Solvay Process Co.* *b e*	Syracuse	Wells: Tully Plant: Solvay
	Schuyler co.	
International Salt Co., Inc. *e*	Scranton Life Bldg., Scranton, Pa.	Watkins Glen
The Watkins Salt Co. *e*	Watkins Glen	Watkins Glen
	Tompkins co.	
Cayuga Rock Salt Co., Inc. *r*	Myers	Portland Point
International Salt Co., Inc. *e*	Scranton Life Bldg., Scranton, Pa.	Myers
	Wyoming co.	
Worcester Salt Co. *e*	40 Worth street, New York	Silver Springs

* In the fall of 1947 the Solvay Process Company was succeeded by the Allied Chemical & Dye Company.

b = brine
e = evaporated
r = rock

SAND AND GRAVEL

New York's position as a leading State in sand and gravel production is in large part a result of its position within the area covered by the last ice sheet. Most of its commercial deposits are glacial in origin and were formed by streams of sediment-laden melt-water pouring into glacial lakes. The sand and gravel are therefore representative of the bed rock which was scoured away during the southern advance of the ice sheet. For this reason, gravels in western New York are high in limestones; those of the Southern tier, high in shale, and those of eastern New York rich in granite rocks from the Adirondacks.

In the environs of the large cities in the State, particularly near New York City and Buffalo, large, stable industries account for a high percentage of the total production. In the neighborhood of the smaller communities production is more erratic, usually depending on the degree of activity in local heavy construction projects.

Approximately half of the total value of sand and gravel is from sales of building aggregate—sand for mortar, sand and gravel for concrete. Paving sand and gravel is second in importance, followed by molding sand and fire sand. Smaller amounts of engine and filter sand, and sand and gravel for railroad ballast are produced. There is no glass sand produced in the State, although deposits exist which were once worked.

Shipments of sand and gravel, 1937–48

YEAR	BUILDING SAND		PAVING SAND		MOLDING SAND	
	Short Tons	Value	Short Tons	Value	Short Tons	Value
1937......	4 017 564	$1 805 540	1 998 839	$848 968	382 402	$703 901
1938......	4 197 958	1 940 031	2 029 633	983 588	249 792	403 418
1939......	*a*	*a*	*a*	*a*	354 113	578 110
1940......	*a*	*a*	*a*	*a*	413 391	688 806
1941......	*a*	*a*	*a*	*a*	624 448	1 010 051
1942......	4 924 640	2 968 564	2 274 915	1 593 011	529 809	851 575
1943......	2 229 292	1 259 347	1 661 970	873 632	432 777	734 689
1944......	1 950 894	1 068 013	1 125 120	540 134	633 110	745 917
1945......	2 889 501	1 570 794	1 168 058	636 059	405 208	664 602
1946......	4 500 050	2 883 333	1 695 860	1 151 452	495 099	900 274
1947......	5 467 488	4 038 073	1 718 449	1 249 338	503 091	1 009 294
1948......	6 650 391	4 998 023	2 189 754	1 722 073	470 275	961 335

YEAR	OTHER SAND		GRAVEL		TOTAL SAND & GRAVEL	
	Short Tons	Value	Short Tons	Value	Short Tons	Value
1937......	168 864	$79 675	5 933 719	$3 049 150	12 501 388	$6 487 234
1938......	387 145	124 363	6 707 842	3 041 699	13 566 370	6 493 099
1939......	*a*	*a*	*a*	*a*	12 608 128	7 050 104
1940......	*a*	*a*	*a*	*a*	13 224 863	7 639 668
1941......	*a*	*a*	*a*	*a*	14 923 149	10 096 875
1942......	95 901	59 532	8 460 102	6 368 563	16 285 367	11 841 245
1943......	203 176	102 291	5 447 768	2 540 591	9 974 983	5 510 550
1944......	310 127	152 829	3 030 332	1 801 497	7 049 583	4 308 390
1945......	209 757	121 833	2 805 104	2 056 617	7 477 628	5 049 905
1946......	296 794	186 542	5 091 446	3 785 499	12 079 249	8 907 100
1947......	307 319	153 471	5 823 849	4 456 048	13 820 196	10 906 224
1948......	303 967	169 609	6 754 916	5 531 330	16 369 303	13 382 370

a Tonnage and value not segregated, included in state total.

Both production and use of sand and gravel have continued to rise, especially since World War II. The predepression level of 19 to 21 million short tons, however, is still considerably in excess of present totals. Even at prewar price levels the 1929 value of $14,919,658 is greater than any before or since.

BUILDING SAND

All loose sands and gravels used as aggregate for engineering work and buildings fall under this heading. More than half the quantity and value of the annual production is used in New York City and environs. A very large percentage of this demand is supplied from tidewater deposits along the north shore of Long Island in Nassau and Suffolk counties. The sands are obtained from Pleistocene marine and morainal deposits which crop out in the bluffs along the shore. Reworked material of identical origin is found in the beaches below the bluffs. This has been sorted by wave action and may therefore be dredged and shipped with no further treatment. The material excavated from the banks is washed and graded from sizes ranging from fine sand to gravel. These deposits are characterized by a predominance of quartz particles. Leading centers of the industry are Roslyn, Glen Cove, Port Washington, Northport, Farmingdale and Port Jefferson. Fire and core sand, engine sand and filter sand are also produced at these localities.

The Hudson valley north of the Highlands is filled with accumulations of glacial clay, sand and gravel. The coarser materials are in large part morainal in origin. Some of them show the rude stratification resulting from stream depositions. In most banks the sands have a composite character and consist of quartz, feldspar, shale and other materials native to the region. For this reason they require considerable washing and sizing before they become suitable for construction purposes. Extensive banks are found at Marlboro, Kingston, Albany, Rensselaer, Troy and Mechanicville.

The larger cities in central and western New York all have satisfactory local supplies. Morainal material and large glacial delta deposits are utilized at Utica, Syracuse and Rochester. Buffalo is supplied from dredging operations on the Niagara river, from Lake Erie beaches and from scattered banks in the environs opened in glacial beds.

MOLDING SAND

Molding or foundry sand is one of the special sands of which there is important New York State production. These are usually known as Albany molding sands, from their common occurrence in the Capital District, and are widely used through the country. They are characterized by a high degree of fineness which makes them particularly suitable for brass casting.

The Albany molding sands are found in the Hudson valley from Fort Edward south to the vicinity of Poughkeepsie. They rest on clay or on "sharp" gray sand and are overlaid by soil or by dune sand. Their characteristic of bonding is a result of the development of clay by the weathering of shale particles which are mixed with the quartz sand. The shale was derived from underlying rock deposits during glacial erosion and deposition. Weathering has been accomplished mainly by organic soil acids.

The average thickness of the sands is 18 inches although banks of eight feet have been worked near West Albany, Elnora and Ushers. At these localities the molding sands, after formation, have apparently been redeposited in lagoons. Removal of the sands is accomplished by stripping the sod and top soil in successive trenches, each about three feet wide, so that the sod and soil of one trench can be shoveled into the adjoining one from which the molding sand has already been dug. The land is usually returned to agriculture after the molding sand has been removed. For that reason the right of digging the sand is usually let by contract by which the shipper agrees to pay a certain royalty either in a lump sum or based on the tonnage obtained.

The grades of sand shipped from the Hudson valley run from No. 0 to No. 4, the coarsest size commonly produced in the district. No. 0 is used in stove plate and fine castings of aluminum and brass. This grade is made up of particles of which 95 per cent or more will pass a No. 100 screen (average grain diameter less than .0058 inch). No. 0 and No. 1 are the sizes for which the principal demand exists, since they are not abundant in the molding sand districts elsewhere.

GLASS SAND

Small quantities of glass sand are shipped occasionally from beds in the vicinity of Oneida lake. At one time these were the main source of supply for an active local window glass industry and large shipments were made also to plants elsewhere in central and western New York. The deposits are of the blanket type, lying just below the soil cover, and vary from six inches to three feet in thickness. The prepared sand after screening and washing contains 97 to 98.5 per cent silica, about .2 per cent ferric oxide and a little alumina, magnesia and lime.

A better grade of glass material has been obtained from the Shawangunk grit in the vicinity of Ellenville. Some layers of the grit are practically pure quartz and after crushing yield a superior material that was employed in the works at Corning.

FIRE AND CORE SANDS

High silica sands from Long Island and from Oneida Lake beaches are very satisfactory for foundry work. Fine sands are used in lining furnaces for iron and steel manufacture, and core sands in making cores for iron molding. The important qualities are resistance to corrosion by molten metal and gases, and uniformity of grain.

FILTER SAND

Sand which is clean, free of clay and lime, and possesses a degree of porosity that will allow water to pass freely but retain the mechanical and organic impurities is desirable for water purification. Long Island quartz sand deposits meet the necessary requirements of grain diameter, porosity and composition.

ABRASIVE SAND

Minor quantities of sand are required by stone dressing plants in sawing and rubbing of marble and other stones. A subangular pure quartz sand with minimum variation of size is called for.

SILVER

The silver produced in New York State during recent years is found associated with lead ore in the Balmat zinc mine of St Lawrence county. At this mine the lead ore and associated silver contribute but a small percentage of the value of the mine deposits. The principal minerals obtained are zinc ore together with a considerable yield of pyrite. Although the Balmat mine reached the production stage in 1928, statistics on production of silver are available only since 1934. At that time the silver recovered amounted to 26,406 troy ounces. Peak production was recorded in 1937 with 41,500 ounces. Due largely to shortage of labor at the zinc mine, operations were curtailed in 1945 with recovery of silver totaling only 14,271 ounces, the lowest since statistics became available in 1934. Since 1945, however, the production of silver has again increased. For the period 1934-48 total silver production in the State has amounted to 430,319 ounces with a value of $314,118. The accompanying table shows recovery of silver in New York since 1934.

Production of silver in New York, 1934–48

YEAR	OUNCES (TROY)	VALUE
1934	26 406	$17 071
1935	21 750	15 633
1936	18 251	14 135
1937	41 500	32 100
1938	37 200	24 048
1939	37 250	25 285
1940	35 720	25 401
1941	37 734	26 833
1942	40 012	28 453
1943	38 004	27 025
1944	25 238	17 947
1945	14 271	10 148
1946	15 786	12 755
1947	22 409	20 280
1948	18 788	17 004

Outside of the St. Lawrence County zinc district, a small quantity of silver has been found in the now inactive zinc-lead mines of the Shawangunk Mountain district. Little is known of actual silver production beyond the fact that in 1918 the St Nicholas Zinc Company reported a recovery of 129 ounces from the lead of their Summitville mine. In view of the considerable amount of galena that was mined at various times during more than a century, it is probable that the ores contained some thousands of ounces of silver but how much was recovered is unknown.

Although thousands of claims or notices of the discovery of gold and silver mines in New York State have been filed in the office of the Secretary of State in Albany, there is no known instance of gold or silver ever having been produced in commercial quantities from any of these properties. The basis for a very large number of claims is the mistaken identity of minerals. The most common error is in the case of mica occurring either in loose flakes or in a mica-bearing rock, the yellow mica being mistaken for gold and the silvery-appearing mica for silver. Another common mineral often mistaken for gold is the yellow mineral pyrite. During the past 50 years considerable attention has been focused on the so-called gold sands of the Adirondacks. These sands, mostly of glacial origin, have been widely advertised as having gold values from two or three dollars to $50 a ton. Numerous tests by assayers have failed to find more than a mere trace of gold—a common occurrence in many types of ordinary rock material. The claim of promoters of various types of gold sand operations often was that the gold present could not be detected by ordinary chemical or assay methods because it existed in some peculiar state referred to by such terms as "nascent," "atomic," or "volatile." Plants to extract the gold by secret methods were erected in some cases, but in no instance was there any authentic record of a single ounce of gold or silver being recovered.

The old law in force for a great number of years relating to the filing of discovery claims of gold and silver deposits on state and private lands, together with outline of conditions under which such claims might be worked, was amended by the State Legislature in 1945 and further amended in 1948. The newly amended law provides a method to cancel old mining claims. It further provides that the land against which the notice of discovery is filed shall be shown on a suitable location map and that the area covered by a claim shall not exceed 40 acres. The cost of filing a claim is $25.00. In order to make certain that mining claims do not remain dormant, the law provides a minimum annual expenditure to be used either for exploratory work or in the extraction of minerals. The full text of the new mining law of the State of New York is contained in chapter 872, Laws of 1948.

SLATE

The end of World War II gave New York's slate trade its first opportunity to recover from the depression years of 1932 and 1933. Beginning in 1936 an upturn in sales was noted with a steady but slow advance until 1945. With the lifting of wartime restrictions on building, the quantity and value of production rose sharply to 1947, the peak year in the history of the New York industry. The trade in granules has shown stronger recuperative powers than that in roofing slate. Ninety-four per cent of the value of New York sales in 1948 was from granules, flour and flagging.

Current production in the Washington County slate district is carried on by thirteen operators. The purchase of 18 nonoperating quarries in 1946 by a Buffalo firm stirred interest in use of the quarry waste for slate, brick and tile, but the firm went out of business before actual manufacture of the contemplated industrial products could begin.

The New York red slate is unique. Green, purple, gray, black and variegated slates are common to both New York and Vermont.

GEOLOGIC OCCURRENCE

Slate is a metamorphic rock derived from shale by strong earth pressures and heat. In regions where folding of the rock has been insufficient to relieve the severe stresses further accommodation is accomplished by reorientation of the minerals. Platy minerals, such as muscovite, chlorite and clay minerals, assume a parallelism which gives the rock a pervasive plane of parting known as slaty cleavage. This seldom corresponds to the original bedding but usually parallels the axial planes of the folds.

The slate beds of the New York-Vermont region outcrop in belts which extend nearly north and south in parallel series. According to T. N. Dale they are Lower Cambrian and Ordovician in age. The Cambrian slates are mainly developed on the Vermont side and yield such varieties as sea green, unfading green, purple and variegated slates. Slates of this age are also found in the quarries north of Granville.

Red slates are characteristic of the Ordovician strata which also include grits, green and black slates and shales. The red variety is discontinuous and irregular in distribution, running into shales or green slate of inferior quality.

The slates have been developed during two periods of compression and folding. The most important came at the close of the Ordovician and developed the slaty cleavage and grain as well as the formation of new minerals. In the sandy horizons quartz was deposited as cement and in veins. At a later time fracture cleavage, shear zones and joints were produced. Openings made at this time were filled with silica and calcite. Some igneous dikes were also intruded.

QUARRY METHODS

Open quarry work is the only method pursued in New York State. Considerable stripping of top soil is often necessary in the preliminary stages. Quarrying follows the slate down dip, so that the pits soon become deep and intermittent pumping is required to keep them dry. Explosives are avoided as much as possible so that the slate will not be shattered. Those blocks unfit for use are dumped on the waste piles. The good slate is loaded on cars or is carried directly to the trimming sheds where the blocks are split and squared into roofing slates. Mill stock and slate to be used for granules do not require trimming or other quarry preparation. For such uses perfection of cleavage is a handicap rather than a desirable quality.

QUARRY LOCALITIES

At present the most active quarry section is limited to a strip nine miles long which extends northward from Granville to Hampton, just west of the Vermont state line. The Hampton quarries have supplied purple, green and red slates. The Jamesville quarries, about two miles farther south, produce red, green and variegated slates. Middle Granville is an important center for production of purple, green and variegated slate for roofing and mill stock. Red and green slates are the principal product of the Granville and Slateville quarries.

Cambrian purple, green and variegated slates have been quarried previously in eastern Washington county as far south as the Hoosick river. Black slates of little economic importance also occur east of the Hudson river in Rensselaer, Columbia and Dutchess counties.

Shipments of slate by New York quarries, 1937–48

		ROOFING SLATE		FLAGGING, GRANULES, FLOUR AND OTHER USES		TOTAL
YEAR	OPERATORS	Squares	Value	Short tons	Value	Value
1937......	20	6 310	$58 062	47 068	$306 962	$365 024
1938......	17	2 780	26 340	54 010	418 991	446 081
1939......	12	2 020	15 740	*a*	450 097	465 837
1940......	13	2 900	24 972	*a*	454 081	479 053
1941......	11	1 780	18 579	*a*	666 566	685 145
1942......	8	2 200	32 518	71 370	627 072	659 590
1943......	5	120	2 379	69 960	611 187	613 566
1944......	5	140	3 140	96 580	787 953	791 093
1945......	6	....	......	95 910	857 465	857 465
1946......	13	....	......	121 100	1 160 404	1 160 404
1947......	15	860	17 905	141 430	1 557 347	1 575 252
1948......	13	3 730	91 988	124 120	1 440 892	1 532 880

a Not available.

STONE

The stone industry of New York has regained an eminent position in the State's mineral economy following the general slump in the late war years. Every part of the State is represented in the quarry industry, although some areas are more richly endowed with stone than others. Low cost crushed stone for use as concrete aggregate, chemical stone and agricultural limestone are the important contributors to the 1948 total of $17,261,486. The value of dimension stone has gradually declined and in 1948 represented less than 2 per cent of the total value. Most of the local demand for dimension stone is supplied by imports from neighboring states.

Granite production in 1948 resulted in a total value of $106,344, a considerable drop from the 1947 total of $228,951.

The major quarry stone is limestone which, in 1948, had a total value of $14,368,124. This does not include limestone used in lime and cement manufacture. The 1929 value of limestone production was the only yearly total in excess of this last year.

No dimension marble was produced in 1948. This is a far cry from earlier production totals. All marble production is now limited to Westchester county and consists of crushed stone sold as industrial filler. Sandstone quarried in 1948 was valued at $427,508. Approximately 80 per cent of this total was in dimension stone—flagging, curbing and paving blocks.

Trap from the Hudson Valley quarries had its best year since 1930. The 1948 production was $1,964,215, as compared with $1,362,924 in 1947. Almost the entire output went for concrete aggregate and road metal. An interesting development was the use of the quarry fines by the State College of Ceramics as a ceramic body and glaze. Very attractive black, dark blue and ox blood ceramic objects have been made from this material.

GRANITE

Granite, as a quarryman's term, includes various massive silicate rocks which may differ in mineral composition or appearance from the rock so classed by geologists. As strictly defined, granite is a coarse-grained igneous rock, consisting of alkali feldspar, quartz and certain iron-rich minerals such as mica, hornblende or pyroxene. As adapted for purposes of statistical compilation in this report the term also includes syenite, diorite, anorthosite and gabbro.

Granite rocks are found in the Adirondacks in northern New York and in the Highlands in the southeast—areas which represent almost one-fourth of New York State. Elsewhere it occurs only as stray boulders which have been transported from some more or less distant source by the continental ice sheet.

The use of granite as a structural material has declined in recent years. At present its principal use is a rough architectural stone.

Sources previously favored for dressed construction stone and monumental granite have been Grindstone and Picton islands of the Thousand Island district, Jefferson county, notable for red and pink varieties; Au Sable Forks and Keeseville, Essex county, with gray to green sorts; Woodgate, Oneida county, with pink granite; Parishville, St Lawrence county, dark red granite veined or banded by lighter material; Peekskill, Westchester county, yellow and light gray stones; Tarrytown, Hartsdale, Dunwoodie, Westechester county, light gray gneiss (Yonkers granite); also Rye, Mamaroneck and Port Chester, Westchester county, with a gray granodiorite.

By far the greater quantity of granite produced is from quarries in Westchester county where granite gneiss is prepared as noble, rough architectural stone, dressed architectural stone and paving blocks. The Republic Steel Corporation has shipped a considerable tonnage of waste rock or tailings from iron mining for concrete aggregate and road construction purposes. The crude tailings are graded into several sizes and may be further prepared by washing.

LIMESTONE AND LIME

New York State is fortunate in its rich endowment of high-calcium limestones, magnesian limestones and dolomites. They include rocks of both sedimentary and metamorphic types ranging in age from the Precambrian through the Devonian. This section is devoted to those varieties which are used industrially. Calcareous building stones are discussed briefly in the section on marble.

Limestone (including magnesian varieties) is distributed widely in the State. The central Catskills, central Adirondacks, the "Southern Tier" and Long Island are the only localities in which it is lacking.

Recrystallized limestone of Precambrian age is common in the country bordering the Adirondacks, especially in St Lawrence and Jefferson counties. Smaller areas are also found in Essex and Warren counties. Rocks of similar age outcrop in Putnam and Westchester counties. High quality dolomite is especially prevalent in St Lawrence county.

Folded Cambro-Ordovician limestones are found outcropping east of the Hudson river in Washington, Rensselaer, Columbia and Dutchess counties and have been a source of lime products for many years. Bordering the Adirondacks are thick bedded limestones also of Cambrian age, the lower ones having a high percentage of magnesian layers. These are the Theresa, Hoyt and Little Falls formations.

The Beekmantown, Chazy, Lowville and Black River formations are Ordovician limestones and are the major rock unit exposed in the valleys which encircle the Adirondacks. They are all carbonate rocks of varying degree of purity and are well adapted to many specialized uses.

The Silurian limestones are of importance in a band extending east-west through the center of the State and in another north-south belt which parallels the Hudson river on the west. The oldest is the Clinton which extends from just east of Rochester to the Niagara river. The Lockport dolomite outcrops in a parallel belt farther south and is exposed from the Niagara river as far east as Herkimer county. The waterlimes and clayey dolomites of the Salina formations have been used for the manufacture of natural cement in Erie and Onondaga counties. The Helderberg limestone series of Silurian and Devonian age outcrops from Buffalo east to Albany county, then trends southward along the west bank of the Hudson to Kingston, Ulster county, and then southwesterly to the state boundary at Port Jervis. Becraft mountain, near Hudson, is an outlier of the same formation. The Helderberg limestones have been extensively worked for the manufacture of portland cement in many places along its belt of outcrop.

Two Devonian limestones have been quarried in New York State. The older is the Onondaga limestone which follows the Helderbergian outcrop pattern. It contains cherty layers so that its use is usually limited to structural and crushed stone. In west central New York in the vicinity of Cayuga and Seneca lakes the Tully limestone is an important source of limestone for portland cement.

Expanded use of limestone in metallurgical and chemical industries promises to make this common material of even greater importance than in the past. As described in another section, high-quality dolomites have been used as an ore of metallic magnesium. Limestone which is low in magnesium and free from phosphorus is used in the manufacture of calcium carbide, a basic material in one of the more important synthetic rubber processes. Low silica limestone is also used in the recovery of aluminum from clay or low-grade bauxite.

In 1948, 11,140,010 short tons of crushed limestone were quarried in New York. This represents seven-eighths of the total tonnage of stone produced in the State. By far the major portion is used for concrete aggregate and road metal.

LIME

Production of lime has dropped since the peak in 1944 of almost one and one-half million dollars, although the current production level is still considerably higher than before the war. Quicklime and hydrated lime are now being produced at only two plants in the State, one in Erie county, the other in Clinton county.

MARBLE

A uniformly low volume of marble production may be noted for 1937-48. The great majority of the marble sold was as crushed marble waste. Production of structural and monumental stone has been practically at a standstill.

The term "marble" is applied by the trade to any limestone that will take a polish. By reason of their physical properties more metamorphosed, recrystallized limestones fit this definition than do the unmetamorphosed varieties.

In the Adirondacks, marble suitable for structural use occurs in Jefferson, Lewis and St Lawrence counties. Quarries in the vicinity of Gouverneur are well known for light and dark gray and blue-gray Grenville marble which takes a fine polish and is desirable for both monumental and structural work. Analyses show it to be more than 95 per cent carbonates, so that it also has industrial uses. Similar types of the Precambrian marble have been quarried at various times near Canton, Harrisville and Natural Bridge. Marble is common in many places in the Adirondack region but seldom in commercial quantity. Ophicalcite, a serpentineous marble was quarried at one time in Essex county. Verd antique has been found in Essex, Warren and St Lawrence counties.

Marbles are found east of the Hudson river in the northeast-southwest trending intermontane valleys of the Hudson highlands. They occur interbedded with quartzite and schists in Westchester, Dutchess and Columbia counties. These are the only quarries currently in operation.

Most of these marbles range in color from white to light gray and many are high magnesian limestones and dolomites.

Nonmetamorphic marbles have been quarried for dimension stone in at least three New York localities. A fine-grained black limestone of Trenton age is exposed in the gorge of the Hudson river at Glens Falls and has been of considerable use as an ornamental stone. Certain layers of the Chazy limestone at Bluff Point, south of Plattsburg, have been quarried as a fossil marble. It is characterized by red and pink fragments embedded in a gray matrix. A rock of somewhat similar appearance is the Becraft limestone at Catskill.

SANDSTONE

Sandstones are sedimentary rocks composed of quartz grains cemented together to form a coherent mass. Inasmuch as the sediments are waterlaid the grains have been roughly sized so that the rocks range from fine grained siltstone through sandstone to conglomerate. The cementing substances have more variety. Silica, hematite, pyrite, siderite, calcite and clay are the more common types of cement. Silica is the most desirable cementing substance—a quartz rock thus cemented is called quartzite. Pyrite oxidizes on exposure to the atmosphere so that sandstones containing a high percentage of this mineral are unsuitable for structural use. Bluestone is a sandstone containing fine black and dark green minerals which impart a blue color to the rock. Sandstones of economic importance occur in the Cambrian, Ordovician, Silurian and Devonian rocks of New York.

The Cambrian Potsdam sandstone is widely exposed east, north and northwest of the Adirondacks. It is also exposed in a few places in the Mohawk valley. The Potsdam is a very hard silicified sandstone or quartzite, white to pink in color and in some places (Bangor, Maine, and Fort Ann) is 98-99 per cent silica. It has been used in the manufacture of ferro-silicon and for construction purposes although it is very difficult to work.

The Ordovician sandstones are fine-grained silty beds which outcrop along the Mohawk-Hudson valleys. These, together with thicker interbedded series of shale, constitute the Hudson River series. The thinner, platy beds are used for flagging and curbing. Municipalities of eastern New York have numerous examples of the use of the heavier sandstone beds of the series as building stone. It is usually buff to brown in color.

The Medina sandstone of Silurian age is quarried mainly in Niagara and Orleans counties, although the same formation extends east into Oswego county. The color is light gray ("White Medina"), pink, brown or variegated. The reddish brown sandstone is preferred for building stone. Curbstones and paving blocks are also produced in some quantity.

Devonian sandstones and shales of the Hamilton, Portage, Chemung and Catskill groups outcrop over most of the State south of the Mohawk and west of the Hudson. It is from these beds that the bluestone of New York is obtained. Much of these Devonian sandstones split into thin slabs with smooth surfaces. It is therefore especially suitable for flagstone and curbstone. The fine-grained blue-gray product from Greene, Ulster and Delaware counties is best fitted for this purpose. Saugerties and Kingston are the main shipping outlets in this eastern district. Heavier sandstone beds of similar age occur in Chenango and Wyoming counties (Norwich, Oxford, Warsaw and Portageville).

The Triassic beds of Rockland county have yielded small quantities of coarse, red freestone for local use.

TRAP

"Trap" is a quarryman's term for any dark, tough stone which may be used as crushed stone for road metal and concrete aggregate. As described in this section trap is considered to be a fine-grained black or nearly black igneous rock.

Most of the trap quarried in New York State is a diabase. This is an igneous rock characterized by the interlocking character of the two chief minerals, pyroxene and plagioclase feldspar. Amphibole, olivine, magnetite and biotite are associated minerals. As a result of its texture trap has a very high crushing strength.

The largest single occurrence of trap in the State is the Palisades of the Hudson and the continuation of the same intrusion southward through northern New Jersey onto Staten Island. The Palisades are the outcropping eastern edge of a diabase sheet that was intruded between sandstones and shales of Triassic age. The diabase dips gently westward, parallel to the sedimentary formation. Although the sill varies in thickness from 300 to 1000 feet, its outcrop along the river is seldom more than a mile wide.

The trap also outcrops at Mount Ivy, west of Haverstraw, and at Suffern in western Rockland county. Quarrying of this rock is now limited to these localities since the outcrop area along the Hudson river was incorporated into the Palisades Interstate park.

Trap occurs as small dikes throughout the Adirondacks. Two of the larger representatives of this type were once quarried at Greenfield, Saratoga county and at Little Falls, Herkimer county.

Production of stone in New York, 1930–48

YEAR	GRANITE	LIMESTONE	MARBLE	SANDSTONE	TRAP	TOTAL a
1930	$830 958	$13 892 218	$372 465	$1 056 611	$1 989 416	$18 141 668
1931	792 976	12 586 558	186 404	692 091	1 297 825	15 598 054
1932	492 537	7 617 699	114 502	348 337	755 297	9 349 273
1933	559 969	4 774 400	105 975	391 219	448 772	6 351 397
1934	705 538	6 497 152	73 452	452 684	727 759	8 516 754
1935	731 506	5 511 867	86 998	462 401	627 444	7 471 063
1936	739 615	7 569 523	126 093	648 103	927 215	10 033 309
1937	788 748	8 705 783	126 983	588 331	978 901	11 352 319
1938	857 230	7 902 074	110 101	519 637	1 000 471	10 527 452
1939	727 206	7 430 857	90 415	668 207	995 110	10 111 032
1940	684 558	7 874 567	74 265	620 464	1 030 725	10 398 401
1941	b	8 985 614	b	368 697	806 955	10 806 450
1942	263 610	9 430 039	140 144	325 512	1 239 255	11 513 020
1943	295 068	6 544 080c	133 805	334 634	1 400 628	8 911 164
1944	b	6 577 696	b	b	b	9 145 433
1945	44 246	7 624 756	b	229 078	1 033 312	9 133 781
1946	82 500	10 154 406	b	371 452	1 267 244	12 086 748
1947	228 951	12 676 404	187 632	371 385	1 362 924	14 992 064
1948	106 344	14 368 124	b	427 508	1 964 215	17 261 486

a Includes value of miscellaneous stone for which no separate column is given.
b Included in state total.
c Crushed limestone only.

TALC

Since the publication of the last report of this series a very detailed investigation of the New York talc deposits has been carried on by the United States Geological Survey under the immediate supervision of Albert E. J. Engel. The results of this work have been summarized in detailed surface and underground geologic maps and in a number of publications.[1] Because Engel's work is so much more detailed and up to date than any other contributions of the past 20 years, this chapter is based in large part upon his summary article in Mining Engineering, which is cited below.

Talc production in the postwar years has followed the trend of the early war years in which production has been uniformly greater than at any time since 1928 and 1929. But in spite of new technics and the recent entry of an additional producer into the field, 1941 with a total of 153,560 short tons remains the peak year. The price for the product rose to an average of over $21.80 per short ton in 1948 to give a total value, even with reduced production, of $2,613,935.

The present producers are: International Talc Company of New York City with mines in the towns of Fowler and Edwards; W. H. Loomis Talc Corporation, Gouverneur, with mines in Fowler township; Gouverneur Talc Company, Gouverneur, with a mine in Fowler township; and the Carbola Chemical Company with a mine near Natural Bridge, Lewis county. Seven talc mills are in operation, six of which are in the Gouverneur district. A comparatively recent development is grinding to extremely fine sizes, ranging from one-half to 20 microns.

USES OF GROUND TALC

New York is the greatest domestic producer of industrial talc. Well over half the annual production is used in the paint industry. The fibrous form of the New York talc has the ability to hold heavy paint pigments in suspension longer and prevents caking and settling. The fibers also act as bonding agents in the paint film.

The ceramic industry is the second most important user of New York talc and the use in this field is steadily growing. Most of the tonnage goes into the manufacture of whiteware bodies (semivitreous tableware, electrical porcelain and glazed wall tile). It is also used in sagger bodies and other kiln furniture.

Much of the talc is used as a filler and dusting agent, especially in

[1] Industrial minerals and rocks. 2d ed. A.I.M.E. 1949. Chapter on Talc and ground soapstone, p. 1018-42. New York talcs, their geological features, mining, milling and uses. Mining Engineering. v. 1, No. 9. Sept. 1949. p. 345-8.

the rubber and insecticide industries. Off-color grades may be supplied for these uses. Talc is used as a filler in putty, wall plasters, linoleum, textile fabrics etc.

Production of talc in New York, 1937–48

YEAR	SHORT TONS	VALUE
1937	96 140	1 215 834
1938	86 423	1 110 024
1939	99 880	1 252 525
1940	113 611	1 402 524
1941	153 560	1 917 732
1942	136 752	1 886 678
1943	136 291	2 003 080
1944	....	*a*
1945	....	*a*
1946	....	*a*
1947	....	*a*
1948	119 716	2 613 935

a Not at liberty to publish.

OCCURRENCE

All of the New York talc deposits are of Precambrian age and are found within a belt of marble. In the Gouverneur district the mineral talc makes up less than 25 per cent of the mined and ground rock. Most of the rock mined is a tremolite—or tremolite-anthophyllite schist somewhat altered to serpentine and talc. The Natural Bridge talcs include types high in serpentine as well as complex aggregates of serpentine, talc, carbonates and diopside.

The talc of the Gouverneur district occurs in elongate zones interlayered within a northeastward-trending belt of impure marble.

The marble belt is apparently part of a highly deformed and metamorphosed flank of a northeastward-trending anticline. Cross folds, plunging north to northwest, foliations, shears and lineations constitute important structural features of the talc zones.

The zones of commercial talc pinch, swell, and curve in sinuous to complexly folded patterns, but are rudely conformable with adjoining marble layers. The talc zones have a composite strike length of more than six miles, a probable extent down dip in excess of 2000 feet and widths of as much as 400 feet. Dips along the talc belts are quite variable, ranging from the horizontal through the vertical, but averaging about 45 degrees to the northwest.

Variations in thickness of the talc belts or of any included zone may be either abrupt or gradual. The belt near Talcville, which contains two producing mines, varies up to 300 feet or more in thickness, averaging perhaps 135 feet thick in the mines. Much of this thickness is commercial talc. A talc belt north of Balmat and southeast and east of Fowler, along which are four active mines, varies up to at least 425 feet in thickness, and averages possibly 125 feet thick. In this belt, however, one or several zones of commercial talc six to 25 feet thick or rarely as much as 75 feet thick are interlayered with impure or discolored noncommercial zones within the belt. Within these two belts are talc reserves sufficient to last several generations, at the present rate of production, under resourceful mining methods.

A wide variation in proportions of tremolite, anthophyllite, serpentine and talc are apparent. Other minerals which occur in and along the talc belts include quartz, calcite, dolomite, hexagonite (a manganese-bearing tremolite), iron and manganese-bearing oxides, diopside, chlorite, pyrite, mica, feldspars, titanite, magnesian and manganese-bearing tourmalines and apatite. Most of these last-named minerals constitute obvious adulterants or impurities and are avoided in mining.

Much of the tremolite probably formed by reactions between, and replacement of, favorable beds of quartzite and dolomite. This initial stratigraphic control of talc distribution was partly obscured and to some extent superseded by prominent secondary structures, especially shear zones that developed during metamorphism.

The talc-forming constituents doubtless were derived largely from the quartzite and dolomite beds, but water, silica, magnesia and other elements were introduced into the present talc belts and calcite removed by hydrothermal solutions.

In general, methods used in mining New York talcs are less progressive than those used in the zinc mines of the same region. Until recently less than 30 per cent of the commercial talc in the larger deposits was recovered. The amount of talc recovered from smaller, complex zones and ore bodies was considerably smaller. In general, however, and especially at Natural Bridge, numerous natural obstacles in the way of efficient operations are presented by complexities of form, structure and composition of these talc deposits. At present capable operators who have introduced modern equipment are in charge in most of the New York mines, and the projected plans of the several companies, if effected, will result in a more ideal exploitation of the important talc deposits.

Both the tabular deposits of the Gouverneur district and the brecciated talcose marble at Natural Bridge have a moderate to steep dip. In these deposits it is common practice to sink a shaft in the talc, on the footwall side of the desired rock. Since the commercial talc is followed by most of the shafts, changes in dip and plunge of the talc body are reflected in corresponding irregularities of the shafts.

One straight, inclined shaft was sunk in 1934 in Gouverneur district, and another vertical, concrete-lined shaft has been sunk to an adjacent talc body.[1]

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[1] *Op. cit.* Mining Engineering, p. 346-47.

TITANIUM DIOXIDE

(Ilmenite concentrates)

Ilmenite is an iron-titanium oxide with the formula $FeTiO_3$, containing FeO 46.75 per cent and titanium dioxide, TiO_2, 53.25 per cent. The mineral is not always uniform in composition. There is always present a small amount of Fe_2O_3 and usually a slight percentage of MgO. The TiO_2 content may be as low as 52.7 per cent. The titaniferous magnetites of the Adirondacks are essentially aggregates of magnetite and ilmenite. By etching a polished surface of the ore the ilmenite grains can be readily distinguished from the magnetite and other dark minerals.

The presence of large bodies of iron ore in the Lake Sanford region was known as early as 1826, but it was not until 1848 that the substance which had presented a serious problem to the blast furnace operations was identified as titanium. The titaniferous magnetites of the Lake Sanford region contain about 16 per cent titanium dioxide (TiO_2). A brief account of the early history and efforts to develop the Lake Sanford deposits for their iron content is given in the chapter on iron ore. The present development of the titaniferous magnetites at Lake Sanford by the National Lead Company was occasioned by the cutting off of imports of ilmenite concentrates, mostly from India, during the early years of the last world war. Although considerable attention had been given since about 1870 to the use of titaniferous ores in the manufacture of various titanium alloys, it was not until 1908 that the possibilities of titanium dioxide as a source of a white paint pigment was demonstrated. The discovery that such a pigment could be made from titaniferous ores provided a stimulus for the titanium pigment industry, which in recent years has shown a remarkable growth. In addition to their use for paint, titanium pigments are in demand for the manufacture of numerous other products. These include white and light-colored rubber, paper, asbestos shingles and siding, soaps, asphalt tile, linoleum, plastics, leather finishes, textile printing, wallboard and white glue.

The resources of titaniferous-bearing iron ores in the Lake Sanford area are large. In the present operations on Sanford Hill the National Lead Company has blocked out a volume of ore of approximately 15,000,000 tons with a titanium dioxide content of 16 per cent. This block of ore is entirely above the level of Lake Sanford. The estimate of tonnage by the MacIntyre Iron Company for the Sanford Hill deposit, including ore below lake level, was 24,263,772 tons with an ilmenite concentrate content of 4,476,523 tons. The estimated reserves for the three largest ore bodies of the Lake Sanford area have been published by R. C. Stephenson in New York State Museum Bulletin No. 340 as shown in the following table.

Estimated reserves of titaniferous magnetite in the Lake Sanford area

ORE BODY	RICH ORE TONS	ILMENITE CONCENTRATE TONS
Sanford Hill	24 263 772	4 476 523
Ore Mountain	17 415 914	3 213 235
Calamity-Mill Pond	9 101 872	1 679 295
Total	50 781 558	9 369 053

In the foregoing the estimates are of ore having an iron content of more than 45 per cent. The ratio of ilmenite concentrates to ore in the Sanford Hill ore body as determined by the National Lead Company is 0.1845:1. The tonnage of ilmenite concentrates was determined by applying this ratio to the ore reserves of the three ore bodies.

A more recent estimate of the reserves in the Lake Sanford area including the small Cheney Pond deposit, has been made by James R. Balsey jr, in Bulletin 940-D of the United States Geological Survey (1943). The total tonnage of rich and lean ore is placed at approximately 38,400,000 long tons and the magnetic concentrates at about 18,570,000 long tons. No estimate of ilmenite concentrates is given in the Balsey report. It is reported, however, that in actual practice at Lake Sanford four tons of ilmenite concentrates are produced for every nine tons of magnetite concentrates. If this ratio is applied to reserves of magnetic concentrates the total reserves of ilmenite of the Lake Sanford area would be approximately 8,245,000 long tons.

Production of ilmenite concentrates at Sanford Hill was begun by the National Lead Company in July 1941, less than a year after the property was acquired from the MacIntyre Iron Company. In the following table the annual production for the years 1942-46 is from the published reports of the United States Bureau of Mines. The 1947 production is from the February 1948 number of Mining and Metallurgy, and for 1948, from the March 1949 number of Mining Engineering.

Production of ilmenite concentrates

Year	*Short tons*
1942	43,923
1943	165,198
1944	216,253
1945	240,090
1946	209,009
1947	252,000
1948	284,000

OTHER TITANIFEROUS MAGNETITE DEPOSITS OF THE ADIRONDACKS

In addition to the titaniferous magnetite deposits in the Lake Sanford area, there are a number of other known occurrences to which brief reference will be made.

Split Rock mine. This mine is located five miles northeast of Westport along the eastern base of Split Rock mountain. The mine openings are just north of Snake Den harbor in the southern face of Split Rock cliff, about 100 feet above the shore of Lake Champlain. The main mass of rock in the mountain is anorthosite with some local intrusions of gabbro in which the ore deposits occur. The ore is in the form of a flattened body ten or more feet thick. Two analyses of the ore gave an iron content of 32.82 and 32.59 per cent and titanium dioxide of 15.66 and 14.70 per cent respectively. The mine was last operated about 70 years ago. A magnetic concentrating plant was located on the lake shore to which the ore was run down in chutes. The location of the mine afforded ready means for lake transportation.

Lincoln Pond mine. This ore deposit, locally called the Kent mine, is about five miles northwest of Mineville. The pit is about 75 feet long and 15 feet wide. A shaft of unknown depth is located at one end. The wall rock is a massive hypersthene gabbro carrying some garnet. An analysis of the ore gave an iron content of 44.19 per cent and titanium dioxide of 12.31 per cent.

Little Pond mines. Little pond is about four miles north of Lincoln pond and two miles south of Elizabethtown. Two openings have been made in the dark basic gabbro northeast of the pond. The north pit is 20 by 20 feet and 15 feet deep. The south pit is 200 to 300 yards southeast and is 30 by 30 feet with a working face 25 feet high. Analysis of the ore from the north pit gave an iron content of 41.57 per cent and titanium dioxide 18.82 per cent. The ore from the south pit contained 29.87 per cent iron and 13.07 per cent titanium dioxide.

Tunnel Mountain mines. The summit of Tunnel mountain is a little more than one mile east of Little pond and the eastern base is at the Black river, which here forms the boundary between the towns of Westport and Elizabethtown. On the extreme summit of the mountain, elevation 1640 feet, an exposed body of iron ore in gabbro has been excavated to a depth of 40 or 50 feet. The pit runs north and south and is ten feet wide. At a vertical distance of 200 feet from the summit and south of it, a tunnel was driven for a distance of 150 to 200 feet. The tunnel was abandoned before reaching the ore. An analysis of the ore gave an iron content of 35.99 per cent and titanium dioxide 16.45 per cent. At the eastern base of Tunnel mountain two ore pits have been excavated on the land of John Tryan. The first was 15 feet square and 10 feet deep. An analysis of the ore showed 24.05 per cent iron and 10.55 per cent titanium dioxide. The second pit, 200 yards northeast of the first, is 15 by 30 feet and 10 feet deep. No analysis is available but the specific gravity (3.964) indicates a higher percentage of iron than in the first pit.

Ledge Hill mines. These mines are located on a hill two miles southwest of Westport. The predominant rock of the hill is gabbro and near the summit two ore pits have been opened. One of these shows a cut 75 to 100 feet long and 30 to 40 feet deep. The other pit is about 25 by 8 feet and is entered by a cut at right angles to its long dimension, 15 by 15 feet in size. No analyses are available of the Ledge Hill ores, but they have all the associations of the titaniferous varieties.

Oak Hill pit. Only a few details are available regarding this small pit in gabbro, which is located about one mile north of New Russia in Elizabethtown. The ore has an iron content of 38.98 per cent and is low in titanium dioxide (5.21 per cent).

Humbug vein. This titaniferous ore deposit is located about two miles north of Mineville and a short distance north of the Cook shaft. The ore, which is probably in gabbro, is reported to contain 20 per cent titanium dioxide.

Titaniferous ores in Moriah township. In this township in which Mineville is located, several occurrences of titaniferous magnetites have been reported. These include the following:

1 West of Mineville on the trail between Mount Tom and Newport pond. An area of gabbro surrounds Newport pond.

2 Four miles west of Mineville and about one-half mile north of Feeder pond

3 Five miles south of Mineville and three miles southwest from Moriah (corners) in rock of gabbro type

4 A mine at Craig Harbor, one mile north of Port Henry, operated more than 100 years ago may be of the titaniferous variety. The ore was smelted with difficulty and this, together with the presence of gabbro in the vicinity of the mine, suggests that it is titaniferous.

Moose Mountain deposits. These titaniferous ores occur on Moose mountain, three miles north of Hammondville and about 13 miles west of Lake Champlain in the town of Crown Point, Essex county. Hammondville was at one time the center of an active non-titaniferous magnetite mining industry. The titaniferous deposits on Moose mountain were opened by the Crown Point Iron Company in an experimental way, but only a few hundred tons of ore were mined. The main pit is perhaps 40 feet long and from four to five feet wide. The country rock in the vicinity of the pit is gabbro which appears to be an intrusion in the anorthosite. An analysis of the ore gave an iron content of about 40 per cent but no information is at hand of the percentage of titanium dioxide.

Port Leyden, Lewis county. The Port Leyden ore body is on the west side of the Adirondacks at a considerable distance from the central Adirondack core of anorthosite. The deposit is really an anomaly among the titaniferous occurrences. The wall rock is not the basic variety belonging to the gabbro-anorthosite family with which are associated the titaniferous magnetites of Essex county. In the Port Leyden mine the wall rock is a quartz gneiss with potash feldspars. Seventy years or more ago a shaft 65 feet deep was sunk and borings were made to a depth of 300 feet. A blast furnace was erected near the mine but apparently the operations were short lived. An analysis of the ore gave an iron content of 40.99 per cent and titanium dioxide of 9.31 per cent.

VANADIUM

The presence of vanadium in the titaniferous magnetites of the Adirondacks is a matter of considerable interest as a potential source of supply since this element has come into extended use in the making of high grade steels. Vanadium is one of the rarer elements. It does not occur native but in various combinations with other elements such as lead, zinc, iron, copper, arsenic and chlorine, it forms some half dozen minerals which constitute the source of the vanadium ores. A simple vanadium compound is the native yellow vanadium pentoxide (V_2O_5) found near Lake Superior. It is known as vanadic ocher. Vanadium when reduced from its compounds is a grayish white metallic powder having a specific gravity of 5.5 and an atomic weight of 51. The elementary vanadium constitutes 77.4 per cent of its oxide (V_2O_5).

In the titaniferous magnetites, vanadium is found only in the magnetite and titanium only in the ilmenite and in rutile when the latter is present. It is not known definitely in what form the vanadium occurs in or with the magnetite. In some of the titaniferous ores from India the vanadium is reported to be present in the magnetite in the form of a mineral which has been named coulsonite, an iron-vanadium oxide, in which the V_2O_5 content is less than 20 per cent. In the Lake Sanford magnetic concentrates some grains resembling coulsonite have been observed but as yet no other vanadium minerals have been found. It is possible, therefore, that the vanadium, or at least part of it, occurs in direct chemical combination with the iron of the magnetite.

A study of the vanadium-bearing titaniferous magnetite deposits of the Lake Sanford area was made by J. R. Balsey jr, and the results were published in 1943 as Bulletin No. 940-D of the United States Geological Survey. This report gives the analyses of four samples of rich ore in which the iron content ranged from 46.6 to 53.4 per cent and the vanadium pentoxide content from .41 to .52 per cent. In the magnetic concentrates the vanadium (V_2O_5) content ranged from .58 to .68 per cent. Four samples of lean ore in which the iron content ranged from 23.6 to 40.4 per cent, had a V_2O_5 content that ranged from .12 to .34 per cent. In the magnetic concentrates from the lean ore the V_2O_5 content ranged from .65 to .95 per cent. It is thus seen that on the average the V_2O_5 content of the lean ore is larger than that of the rich ore. The magnetic concentrates from the rich ore is, however, much more abundant than the concentrates from the lean ore. The recovery of vanadium from magnetite is accomplished by a metallurgical process whose efficiency according to Balsey "is directly proportional to the amount of contained vanadium and inversely proportional to the amount of contained titanium." On the basis of a maximum recovery of 20,800,000 short tons of magnetite concentrates in the Lake Sanford area, the vanadium content as of 1942 was estimated to be 158,000,000 pounds of vanadium.

In the chapter on titanium dioxide (ilmenite concentrates) in this report some 15 deposits of titaniferous magnetites outside of the Lake Sanford area have been briefly mentioned or described. While it is believed that all these deposits contain vanadium pentoxide, analyses of only six are available and these are taken from report of J. F. Kemp published in New York State Museum bulletin No. 138. The localities and vanadium pentoxide content of the ores are as follows:

	V_2O_5 Per cent		V_2O_5 Per cent
Split Rock	.55	Little Pond (north).....	.62
Tryan Pit	.34	Little Pond (south).....	.50
Tunnel Mountain	.61	Lincoln Pond	.04

The presence of vanadium in the Adirondack titaniferous magnetites was mentioned as early as 1898 by A. J. Rossi but the ore at that time was not considered a source of vanadium. In 1910 Professor J. F. Kemp in referring to these ores states, "The presence of vanadium in these ores is a matter of much scientific interest and since the element has come into such extended use for high grade steels some have looked to the titaniferous ores as possible sources."[1]

WOLLASTONITE

The mining of wollastonite (calcium silicate) in New York State is a completely new development since the last report of this series. This mineral was first noted in the vicinity of Willsboro, Essex county, N. Y. about 1810. Recent exploration and development indicate that the deposit is of adequate size for continued exploration on a larger scale than the present operations. The only other known occurrence of like magnitude in this country is in Kern county, California. In 1947 a pilot plant was set up under a federal grant so that studies pertaining to the milling, beneficiation and utilization of the mineral could be carried out. Ceramic testing under this grant was done at the State College of Ceramics. "As a result of the study, a new industry is in the process of being started in a region that offers few opportunities for continuous employment throughout the year. A small corporation owning the mineral rights has been formed and this group has given an option on the development and processing of wollastonite to an organization well qualified to finance the new industry and market the products."[2]

The Essex County wollastonite has been found outcropping at numerous separate localities in a belt of contact metamorphosed sediments, one-fourth mile wide, which begins two miles southwest of the village of Willsboro and trends northwest for approximately

[1] N. Y. State Museum Bul. No. 138 (1908) p. 147.

[2] Wollastonite, an industrial mineral. Bulletin No. 4. Ceramic Experiment Station. New York State College of Ceramics, 1949.

six miles. In this belt Precambrian limestones and associated rocks have been metamorphosed by the intrusion of nearby Adirondack anorthosite, the major rock of the central Adirondacks. The wollastonite and associated minerals have resulted from the contact metamorphism.

The chemical and physical properties of wollastonite, particularly its lathlike shape and its relative ease of separation, fit it for highly specialized uses. Among important uses developed by experimentation are: wall tile, ultra fine pigment, paint filler, thermal insulation, mineral wool, welding rod flux and various types of ceramic bodies.

Production since 1944, the first year, has been small (less than 300 tons annually) but arrangements for expansion in production have been concluded. The price has fluctuated depending on use from $9 to $20 a ton.

ZINC

The type of zinc ore mined in New York State is known as sphalerite (ZnS). It is also known as zinc blende, or merely blende, and sometimes as blackjack. When pure the ore contains 67 per cent zinc.

The two regions in New York where zinc mines have been opened are rather remote from each other and the zinc ores are associated with rocks that differ greatly in geologic age. In the Edwards-Sylvia Lake district of St Lawrence county, the zinc ores occur in the ancient Grenville series of limestones which are of earliest Precambrian age, whereas the zinc deposits of the Shawangunk range in Ulster, Sullivan and Orange counties are found in rocks of Silurian age.

Although zinc ores were known to exist in the Edwards-Sylvia Lake district as early as 1835 it was not until about 1903 that serious prospecting was undertaken which resulted in the development of the Edwards mine in 1915. Since then, two other zinc mines have become producers, one of which, the Balmat, third in volume of production ranks (1946) among the zinc mines in the United States.

The retarded development of the zinc deposits of St Lawrence county for about 80 years after their discovery may be explained in several ways. In the early days the object of search was for lead rather than zinc since there was little use for the latter metal at that time. In most of the deposits the zinc ore was mixed with pyrite and galena, and the separation of this mixture by the only methods then known was too much of a problem for the success of the operations.

Another factor that contributed to delayed development, not only of the zinc district but of mining in the Adirondacks in general, was the long established practice of separate ownership of mineral rights. In Colonial days large tracts of land were deeded by the English Crown and after the Revolution the practice was continued by New York State. In many instances when land was subdivided and sold the mineral rights were reserved. Occasionally these rights were sold to mining companies but in many cases they were handed down to a constantly increasing number of heirs. This practice resulted in complications of ownership which, after a lapse of several generations, made it almost impossible to obtain legal titles to mineral rights for the purpose of establishing mining enterprises. Many of the difficulties existing heretofore, which related to old mineral rights, filing of claims and the working of mines on private and State lands outside of the Forest Preserve, have now been overcome by a law passed by the Legislature in 1945, and by amendments thereto passed during the 1948 session of the Legislature.

At present three zinc mines are in operation in New York State. When first opened in 1915 the Edwards mine was operated by the Northern Ore Co. of Edwards. In 1924 the mine was taken over by the New York Zinc Co., Inc., of Edwards and in 1926 it was purchased by the St Joseph Lead Co. with offices at 250 Park av., New York. The transfer in ownership of the Edwards mine also included an option on the then undeveloped Balmat zinc mine located near Sylvia lake, ten miles southwest of the Edwards deposits. In 1928 the St Joseph Lead Co. brought the Balmat mine to the production stage and not long after it became one of the leading producers of zinc in the United States.

In the region between the Edwards zinc deposits and the Sylvia Lake area, a distance of about ten miles, a half dozen zinc prospects have been found, of which only one has been developed into a productive mine. This mine is located at Hyatt, southwest of Talcville and about four miles from Edwards. The Hyatt deposits were under development in 1918 by the Dominion Company of Gouverneur but only trial shipments were made after which the Hyatt Ore Co. took a lease, started shafts and produced some zinc ore. In 1922 operations were terminated by the Hyatt Company. Renewed tests at the Hyatt property were under way about 1936 by the Universal Exploration Company, a subsidiary of the United States Steel Corporation. During recent years the mine has produced substantial quantities of zinc.

Among the prospects that have been under investigation in recent years are those on the Parker estate along the south and southwestern shores of Sylvia lake. The Parker property is not far from the Balmat mine and several promising surface exposures gave encouragement for considerable testing of the property. According to reports the St Joseph Lead Co. conducted a series of tests after which they relinquished their option. Another zinc company is said to have conducted some drilling tests and then relinquished their rights. In 1940 and 1941 the American Metal Co. made additional tests after which the property was taken over by the Northern New York Development Co. With the aid of a federal loan this company started a shaft which in 1943 had reached a depth of 180 feet, considerably short of the planned depth. Labor, water and financial difficulties have held up the completion of the shaft and mining of the zinc ore.

In the limestone area between Sylvia lake and Edwards, there are undoubtedly some important, undiscovered zinc deposits. For the most part the limestones occupy low ground and are rather generally covered with glacial deposits. As a consequence few outcrops occur and the main reliance in prospecting is on the core drill.

In the Shawangunk Mountain region the principal zinc mines that have been worked in the past are located at Ellenville, Summitville, Otisville and Guymard. The Ellenville mine is the most northerly in the Shawangunk district and was first opened about 1820. Its period of greatest activity was 1853-57 when it was operated by the Ulster Company. During the years 1904-05 the mine was operated by the Ellenville Zinc Company after a new milling plant had been erected on the property. More recent activity occurred at the mine in 1917 when the shaft was unwatered and some prospecting was carried on by the Empire State Zinc Company. No data are available as to the amount of ore taken from this mine which is of interest mainly for the many beautiful groups of quartz crystals it has yielded.

The Summitville mine, originally known as the Shawangunk deposit, was extensively worked during the years 1830-40. A detailed account of operations during this period is given by Mather in Geology of New York, Report on the First District, 1843. For a brief period during World War I operations at the mine were revived by the St Nicholas Zinc Co. The ore consists of sulphides of zinc, lead, copper and iron. From the 1918 shipments of lead a small percentage of silver was recovered.

The Guymard mine, located just north of the Erie Railroad station at Guymard, is said to have been discovered in 1862 and during the years 1863-70 was operated by the Guymard Lead and Zinc Co. For the entire period the total output of zinc and lead ore was about 10,000 tons. The mine was again opened briefly during the eighties. In 1917 it was partly unwatered but this activity did not result in the mining of any ore.

Near Otisville, a few miles north of Guymard, is a mine once worked by the Washington Mining Co. but few details are available regarding its activities. In 1906-07 the property was prospected by the Phoenix Lead Co. of Paterson, N. J. although operations did not reach the production stage.

Another zinc ore occurrence is described by Mather as "situated on the Shawangunk mountain about one mile east of Redbridge, and six or seven from Wurtsboro, at an elevation of 600 or 700 feet above the valley." In 1838 and for some time afterward the deposit was worked by the North American Coal and Mining Company but no details are available as to the outcome of mining operations.

In addition to the two districts where active mining operations have been conducted there are a number of localities in the State where sphalerite is found in small quantities usually in association with Paleozoic limestone. One of these is a limestone quarry west of Saratoga Springs; others include Salisbury Corners, Martinsburg and several in the Mohawk valley. In the Lockport and Clinton formations of western New York sphalerite occurs in the lining of small cavities and in stringers. At Lockport and Rochester are examples of such occurrences.

Production of zinc in New York, 1930–48

YEAR	ORE TREATED SHORT TONS	ZINC SHORT TONS	VALUE
1930	270 601*	22 471	$2 157 216
1931	269 582	24 100	1 831 600
1932	189 679	16 794	1 007 640
1933	180 670	17 733	1 489 572
1934	282 952	23 188	1 994 168
1935	295 179	23 720	2 087 360
1936	377 451	26 941	2 694 100
1937	464 870	32 690	4 249 700
1938	385 600	29 896	2 870 016
1939	420 000	36 014	3 745 456
1940	432 219	35 686	4 496 436
1941	488 079	38 446	5 766 900
1942	548 816	45 807	8 520 102
1943	513 945	46 000	9 936 000
1944	423 557	35 541	8 103 348
1945	325 102	24 978	5 744 940
1946	392 266	32 515	7 933 660
1947	437 893	34 116	8 256 072
1948	464 049	34 566	9 194 556

* Includes 60,000 tons of old tailings retreated.

Since the opening of the Edwards zinc mine in St Lawrence county in 1915 there has been continuous production in the district. In 1928 for the first time since the opening of the mines the metallic zinc recovered from the ore treated exceeded 10,000 tons. The accompanying table gives production of zinc in New York since 1930. The ore treated accounts not only for the zinc reported but ore from one of the mines contains also pyrite and galena, the latter when refined, yielding not only lead but some silver as well.

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CONTENTS

ILLUSTRATIONS

Dayton Stoner

BIRDS OF WASHINGTON PARK, ALBANY, NEW YORK[1]

By

Dayton Stoner Ph.D.
Former State Zoologist, New York State Museum

and

Lillian C. Stoner A.B.

INTRODUCTION AND ACKNOWLEDGMENTS

The esthetic and recreational features of Washington Park, Albany, New York, are outstanding among the city parks of the State. As a contribution to the further enjoyment of these fundamental values, and to the general ornithology of the Albany region, the present nontechnical account of the birds known to occur in, and to fly over, the park is offered. Observations on the birds of city parks in various parts of the country have proved to be of interest, and it is hoped that the present account will provide a helpful service for those who are, or who may become, interested in the birds of Albany and vicinity.

The field studies upon which this report is based were begun in the spring of 1933, and carried on by the joint authors each vernal season through 1942. Partial records, including a few in the fall, were made in 1943, while ten trips were taken in 1944 up to May 8th, when the sudden death of the senior author occurred. A few early records and notes on two additional species from 50 day lists made in 1945 and 1946 by the junior author also are included. Practically all of the trips taken in the first ten years were by the two observers working together. The photographs, with exceptions noted, were taken by Dr Dayton Stoner while acting as State Zoologist of the New York State Museum, and brief abstracts of half of the annotated list of the birds observed in Washington Park were written by him (these are indicated by an asterisk). The completed and new accounts as well as the remainder of the bulletin (and compilation of it) were written by Mrs Stoner while she was working temporarily at the same museum after her husband's death. Quotations in the report unless otherwise specified refer to original notes kept meticulously by Doctor Stoner.

[1] Manuscript submitted for publication May 1947.

This report relates chiefly to the spring occurrence of birds in a park near the downtown area of a city of about 134,000 people. A brief description of topographical and vegetational features, along with seasonal variations in the latter, is given in relation to the bird population of the area. The birds that the authors recorded during the first ten years of this study are listed alphabetically in table 4 (page 36), with composite records for 1933-41 and detailed entries of 1942 observations. The greatest number of species recorded for any one day was 52 on May 18, 1938; a list of these in the order in which they were seen may be found on page 34.

The annotated list treating 122 species and subspecies observed by the joint authors consists of 119 birds recorded in the 1933-42 study with three other birds added in the 1944-46 observations. No systematic attempt has been made to include published records, earlier accounts or reports of other local observers, but five species credibly reported by others are listed (see page 46). No records are included except those of the species, which in our opinion were *identified with certainty.*

In the descriptions of the birds only the approximate length and main field characters are mentioned. The relative frequency of occurrence (table 2, page 30) and mention of our first and last dates (page 250) for each bird observed in the park are given with the thought that these might aid new observers in identification of the birds they see.

The absence of regional species from our list does not necessarily mean that they do not occur in the park. If more time could have been devoted to the work more birds would have been seen. By way of illustration, another observer reported a duck resting on the lake at dawn on March 29, 1945. He identified the individual by binoculars as a lesser scaup as it took flight. The junior author arrived at this part of the park a half hour later so missed seeing the bird. It is not included in our total of 122, but along with four other species, named by Judd (1907, p. 164-65) as mockingbird, yellow-breasted chat, vesper sparrow and orchard oriole, is added to make a total of 127 recorded for Washington Park. Other ornithologists, no doubt, may have different arrival and departure dates from ours and our first and last records do not necessarily represent the extreme seasonal occurrence of the birds.

The annotated accounts of species and subspecies are arranged in accordance with the Check-List of the American Ornithologists' Union, fourth edition, 1931, as modified by the five Supplements published in *The Auk.* (See References for the notations on the Supplements.) Following the designation of the orders and families, are the common and scientific names, the latter as given in the Check-List and Supplements. For simplicity and brevity, however, when the common name is mentioned in the text, a shortened form is often used—as junco, robin and downy woodpecker rather than common slate-colored junco, eastern robin and northern downy woodpecker. The word species is often loosely used when referring to different kinds of birds when one or more may have been subspecies.

Acknowledgment is here given to Dr Carl E. Guthe, Director of the New York State Museum, for making it possible for the junior author to complete this report after the death of her husband. His advice and encouragement have been of invaluable aid.

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We are indebted to several city and park officials, including Forester A. B. Dorsman, for various courtesies, including permission to reprint an early map of Washington Park.

WASHINGTON PARK

Washington Park, which is located in the heart of the city of Albany, New York, contains 90 acres. While the map on page 17 was made by city officials in 1891, it shows the present boundaries. Some of the adjoining street names have been changed and certain additions in the park have been made, as the King statute of "Moses Smiting the Rock" in the center of the formal garden, and the Soldiers and Sailors Memorial at the north end of Knox Street path. The old skating and boat house was replaced in 1928 by the lake house and the adjoining open air theater. Many shrubs, bushes and trees have been added or removed.

BRIEF HISTORY, SIZE AND LOCATION

In the book entitled Public Parks of the City of Albany, New York, published in 1892, the author, William S. Egerton, superintendent of parks, describes the agitation for parks as early as 1859, especially as reflected in the newspapers. Benefits that could be derived from proposed extensive parks were enumerated in a communication submitted to the Common Council in 1863; the following excerpt is of interest:

> "The paper shows that cleanliness, fresh air, the presence of vegetation are essential to health; . . . that a beautiful park in any city is a great moral power, and does more than criminal courts or policemen to repress crime. Men are wiser, better, more temperate and loving, when they have wandered amid trees and by waterfalls, *and heard birds sing* and children laugh and play."

A Board of Commissioners of Washington Park was organized May 8, 1869, as recorded in Chapter 582 of an Act in Relation to a Public Park in the City of Albany and which was passed May 5, 1869. We quote:

> "Section 1. The property in the city and county of Albany known as the burial ground property, the penitentiary grounds and the almshouse farm, are hereby set apart and devoted to the purpose of a public park, to be known as the Washington Park of the City of Albany."

After a law was passed that permitted addition of "such other property as might be acquired by purchase or otherwise," the following paragraph appears in the minutes of the Common Council:

> "Washington Square, or the Parade Ground, situate between State street, Madison avenue, Willett and Knox streets, ceded to the commissioners by the law above referred to, was duly considered in the plan for a new park, and ground was broken early in July 1870, for its improvement."

In an "analysis of areas maintained" at the end of 1891, Washington Park was described as having three miles of drives, six miles of walks, six acres of lake and 65 acres of mowed lawns—a total of 90 acres. These dimensions still prevail but the roadways, formerly gravel, are now paved and are used by hundreds of automobiles. Using names of today, the park is bounded roughly by Lake avenue, Englewood place, State and Willett streets and Madison avenue.

We think that this idea (which the superintendent had in 1869) of hearing birds sing in a park is especially suitable in a city which has highways that were named years ago and which still stand as Eagle, Hawk, Swan, Dove, Lark, Robin, Quail and Partridge streets.

Reference is also given to willows and elms in the early accounts and present park officials consider that some of the stately American

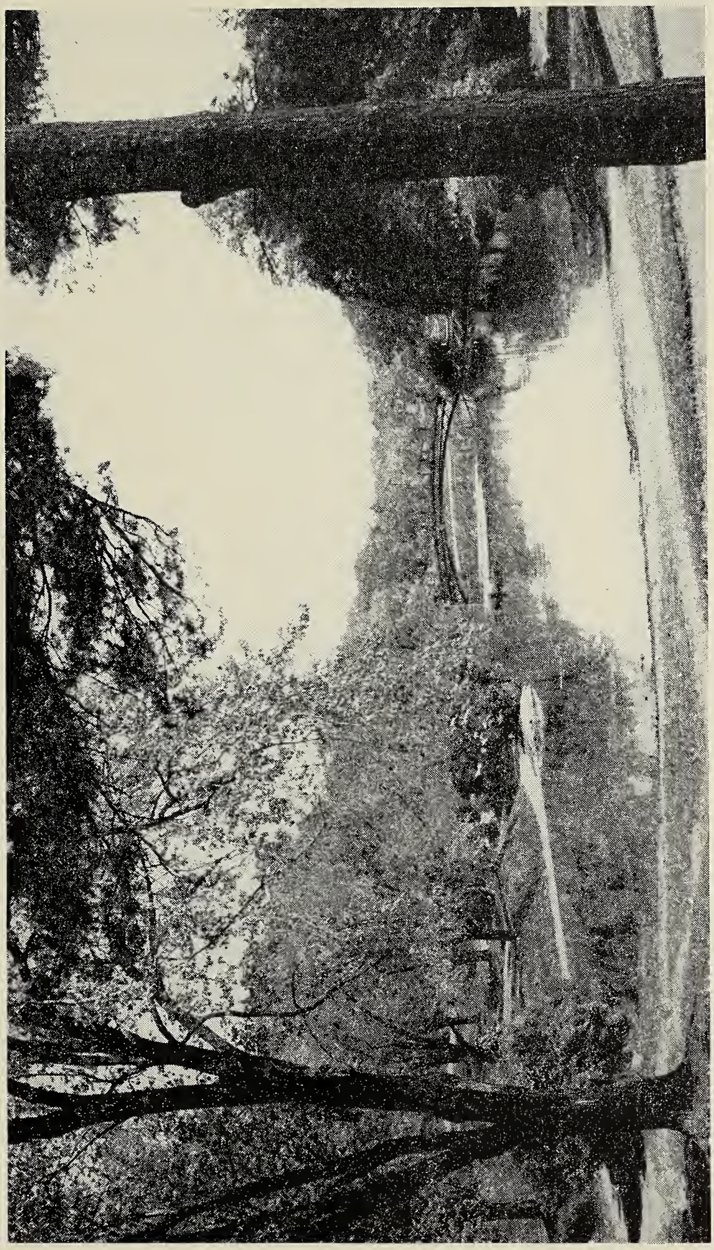

FIGURE 1 Western entrance of Washington Park. May 16, 1941

FIGURE 2 Section of survey map, published in 1866 in New Topographical Atlas of Counties of Albany and Schenectady, New York, shows much of area now known as Washington Park. Names of parallel north-south streets shown here are Robin, Snipe, Knox, Lark and Dove. Some of the American elms that were in and at east end of cemetery (later known as Knox Street path) still remain today.

elms are more than 150 years old. These are the trees that now encircle the croquet grounds (which was formerly part of the old cemetery) and the double row bordering Knox Street path, which today is the south-north path from Knox Street-Madison Avenue intersection to Northern Boulevard entrance at State street. Some observers even estimate that these elms and also some silver maples along State street may be nearer 200 years old. Most of the old plantings of willows were removed a few years ago.

LOCAL SETTING AND RECREATIONAL FACILITIES

The irregular boundaries of Washington Park and the natural settings of hills and ravines that have been maintained, add to the attractiveness of the area for both birds and man.

The human population is interested in the two main buildings, the lake house and the refectory, and in the different shelters such as the one near the croquet grounds which contains a drinking fountain. They also enjoy the recreational features provided by the tennis, croquet, swing and playgrounds. For the comfort of visitors many seats are provided along the various paths and scattered over the lawns and under the trees. Again visitors derive pleasure from the beautiful formal gardens and plantings, but few wild birds are observed here in these conventional settings.

The existing physical features of this park, namely the many large trees and fair-sized body of water are, we believe, the main inducements for attracting birds here. Some stay permanently, others only during migration or nesting periods. Most of our observations of birds were made in the western half of the park, on some 44 acres, which are least used by the public and where there are no flower beds but many trees, shrubs and the long narrow lake. On a good bird morning in May, however, many warblers, scarlet tanager, rose-breasted grosbeak, indigo bunting, purple finch and some sparrows may be seen in the eastern half of the park. They have been observed especially in the tops of the tall elms that surround the croquet grounds and which border Knox Street path. Some birds have been noted near Willett street and one year sparrow hawks frequently were seen resting in trees along Madison avenue near Willett street. Screech owls also have been heard in eastern and southeastern parts of the park.

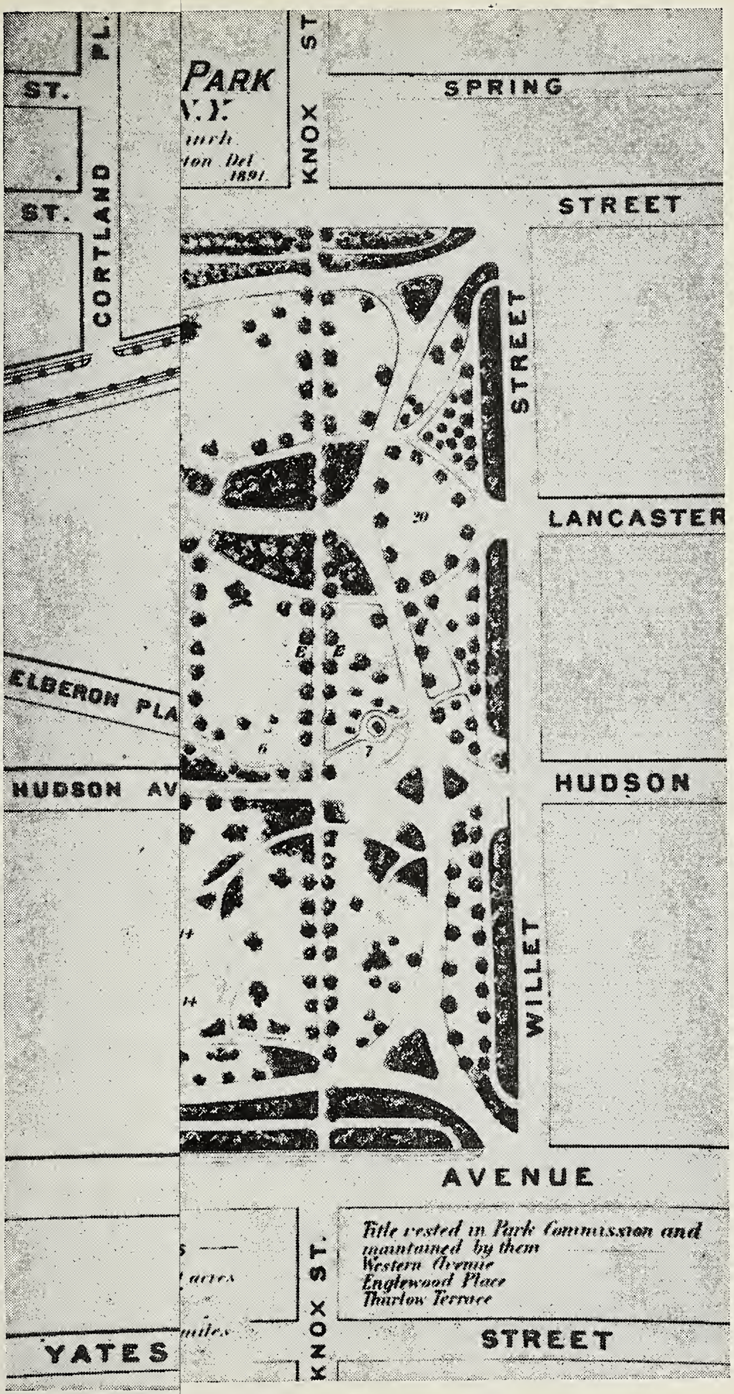

FIGURE 3

Japanese quince	Q
Poplars	P
Adjoining vacant lots	VL

FIGURE 3 Washington Park of today is quite similar to that pictured in this city map of 1891. A few selected spots which the authors found to be especially good for observing birds are designated as follows:

Larch stands	L	Japanese quince	Q
White pines	WP	Poplars	P
Groups of elms	E	Adjoining vacant lots	VL
Maples	M		

PARTIAL LIST OF PLANTS[1]

In order to further beautify this sanctuary, Washington Park officials have added many introduced trees and shrubs to those which are native to Albany area.

To aid the amateur observer in identifying some of the plant life where the birds rest, feed and nest, a partial list of plants is here given.

Trees

White pine
Austrian pine
Red pine
Scotch pine
European larch (tamarack)
Hemlock
Cypress
Blue spruce
Norway spruce
Lowland fir
Red cedar
Arbor vitae
Ginkgo
White poplar (silver-leaved)
Black willow
Gray birch
Paper birch
European copper beech
Weeping beech
Red oak
English oak
American elm
Wych elm
Camperdown elm
Cucumber-tree
Japanese magnolia
Hawthorn
Rowan tree (European mountain ash)
Crab-apple
Blackthorn plum
Mazzard cherry
Redbud
Black locust
Norway maple
Schwedleri's maple
Red japanese maple
Silver maple (white)
Horse-chestnut
Small-leaved (European) linden
American linden
Flowering dogwood
White ash

Shrubs

[2]Mock orange
Spiraea (several species)
Japanese quince
Forsythia
Lilac
Honeysuckle (*lonicera tatarica* and others)

Aquatic plant

Pondweed (*potamogeton crispus*)

ECOLOGICAL RELATIONSHIP OF VEGETATION, LAKE AND BIRDS

The above-named plants along with others, both native and foreign, include an estimated 2400 trees in this 90-acre park, to say nothing of hundreds of shrubs including spiraea, Japanese quince, forsythia, lilacs and honeysuckles.

The park has some 250 trees, mainly maples and elms, located just inside or outside its boundaries; there are more than 150 large trees on the Madison Avenue side alone. Over 80 trees are planted between the lake and the driveway around it; and in all about 225 trees border the three miles of driveways.

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[1] Names for most part are those of Rehder.
[2] Sometimes called syringa.

The more than 20 tall white pines, together with a few scotch pines, along State street between Northern boulevard and a block west of Sprague place (formerly called Snipe street) and two other stands, one near Lake avenue and the other on top of the hill at the southwest corner of the park, are an attraction for many grackles. Cowbirds often take the very tips of larch, spruce, cedar or ginkgo trees for a lookout or resting place, while grackles and rusty blackbirds occasionally use them. The red and Austrian pines are especially attractive to the yellow-bellied sapsuckers which also visit the hemlocks, cedars, camperdown elms, ashes and maples.

Three groups of about 100 larches (which we frequently refer to as tamaracks) allure crossbills, pine siskins, and warblers. The kinglets and chipping, English and white-throated sparrows, and some of the thrushes find safety in the decorative blue spruces along Englewood place.

A degree of security is given to many warblers and woodpeckers, and unfortunately perhaps to starlings, by the tall white poplars which are located in the ravine and on the sloping hill just north of the park bridge.

The commonest and tallest trees in the park, the American elms, are found in scattered places beside in the formal square around the croquet grounds, near the drinking fountain shelter and in the two long rows on either side of Knox Street path. Their dense foliage and drooping branches give excellent protection to warblers and other species both during migration and nesting seasons. Many of these trees have an estimated height of 100 to 120 feet.

Three members of the woodpecker family, namely the flicker and the hairy and downy woodpeckers, make their nest holes in the maples, especially the silver maples that bound the lake on the north. The three large silver maples near State street which are well over 100 years old and not only are about 90 feet high but have the largest girths of any of the park trees, have such thickly leaved tops that they provide many birds with safe retreats.

The variety and diversity of shrubs are pleasing to the public eye and these bushes also afford protection to birds. The dense plantings of Japanese quince on the north bank of the lake near the bridge, along with other near-by shrubbery when not too closely trimmed, are attractive to catbirds; an occasional nest is found here or in the lilac or spiraea bushes. Hummingbirds are attracted to the blooms of the Japanese quince and the various honeysuckles which are scattered throughout the park.

There are practically no locally indigenous herbs in the park. Most of the turf is composed of introduced lawn grasses and of numerous weeds that persist despite mowing. In the order according to the numbers seen, starlings, English sparrows, grackles, robins and flickers spend part of their time on the ground and get some of their food and nesting material there.

During the summer days and evenings many persons, especially children, avail themselves of the boating privileges of the six-acre lake. Hence the birds use the water more during the early morning hours, especially for bathing. Soon after sunrise, particularly on warm days, we have seen grackles, robins, English sparrows and a few other species splashing in the shallow edge of the lake. Then later they stand or lie on the near-by shore as they sun and preen their feathers. Birds are frequently seen flying down to the margins of the lake to get a drink.

This body of water, which has an average width of 150 feet, depth of seven to ten feet and length of 1750 feet, is spanned midway by an elliptical wrought-iron bridge; the highest central portion of this bridge is an advantageous spot for observing birds that may either be in or over the park. Undoubtedly, the lake, surrounded by so many big and old trees, is the attraction which draws many weary migrants as well as summer birds to Washington Park.

Since the park provides a safe shelter for a variety of birds, it is an excellent place for urban bird enthusiasts to study them. The birds are largely safe even from observation; if one does not realize this, let him try to locate, with or without binoculars, some of these tiny warblers among the moving leaves and shadows, 65 to 120 feet above the ground.

By way of contrast, we mention the only other large park in Albany, namely, Lincoln Park, about a mile distant. Comprising some 74 acres, it was developed partly from a dump pile in 1910; additions were made in 1922 to round out the present beautiful tract. Most of the trees, which include few evergreens, are younger and smaller than those in the older park and are not so densely planted. The swimming pool, the only body of water here, attracts people but not birds. While there is a considerable planting of lilacs and other shrubbery on one hillside near the pool, there is no general shelter for migrating or nesting birds comparable to that provided by the many high, old trees in Washington Park. Certain species such as the grackles that are so commonly seen in the larger park are rarely seen here.

ORNITHOLOGICAL OPPORTUNITIES OFFERED BY A CITY PARK

Contrary to the popular opinion that birds other than pigeons (rock doves), robins, English sparrows and starlings are found only in the country, and that one, therefore, must go there to see them, Washington Park is an area well suited to the beginner in bird study. The following reasons are given in support of this statement:

1 The number of species is more or less restricted because of the limited types of habitat and the discouragement offered many birds by the ordinary city noises.

2 The influx of great numbers of individuals and species during spring migration is not so sudden, nor so marked nor in such great profusion as to bewilder the amateur.

3 Therefore, the persistent student may apply this slowly acquired knowledge to wider fields when he attempts to identify more of the over 425 species and subspecies in New York State.

This central city area is accessible to urban dwellers for more frequent trips—far better for progress in bird study than an occasional country visit—and provides a place where not only permanent or summer resident birds but also a considerable number of migrants may be observed. Individuals may pause briefly in this restful refuge or migrant species may be represented for days or even weeks. More land than water birds are seen but the proximity of the Hudson river, which serves as one of the migration highways of the Atlantic flyway, results in a few water birds flying over the park.

The desirability of frequent trips can not be overemphasized as the bird population may vary considerably from day to day. Some migrants travel at night, others by day, and there may be daily changes in visitants, especially of warblers during the first half of May. It is advantageous to make observations in the early morning hours when there is less auto traffic through the park and fewer persons on the paths and lawns than later in the day. Birds often either give call notes or sing early in the morning. This helps the observer to find them and to recognize the species both by hearing and seeing the individual. Birds may frequently be identified by song but experienced field ornithologists do not approve the formal recording of species on the evidence of hearing alone. One of the reasons for caution in this respect is imitation of the notes of some birds by others. In Washington Park starlings habitually in late winter and spring mimic the calls and songs made by various species.

CONDITIONS AFFECTING BIRD POPULATION

THE SEASONS

The vernal seasons of the different years covered by this report are designated as early or late according to their average temperatures. The temperature, barometric pressure and direction of the wind were recorded for each trip as the weather is an important factor in the bird possibilities of each day. For example, even in early or mid-May, when numerous warblers are passing through Albany, many birds will be missed on a wet morning when there is a sharp, northerly wind. While numerous individuals may be here, they are inactive during cold showers. Then too, most of the migrants are insectivorous and when the weather remains cold, their food supply is reduced and they do not come or stay in the usual numbers.

In the following account "average temperatures" are averages of those taken at the start of each recorded trip, and not of all the days in each month.

In the first three years this study was not undertaken too seriously, then the effort was increased and more trips were taken with the thought of making a comprehensive report. Due to other bird work in another locality from May 21st to 29th in the years 1933 to 1942, no field work for those periods was included in this study. The number of birds new to the study each season is given to lend encouragement to amateurs to keep lists and see how many additions may be made from year to year.

1933 The season was cool and fairly late. The average temperatures of 35.0° and 50.0° for April and May, respectively, were recorded on ten trips taken between March 31st and May 18th. A high of 62.0° was noted for May 3d. For the 51 species observed this year, see condensed list in table 4 (page 36).

1934 This season started late with remains of winter snow evident on April 6th and vegetation was slow in developing. Fairly warm weather began about the middle of April and brought the monthly average temperature to 43.6°, while May had an average of 52.0°. On 13 trips taken between March 31st and May 16th, 57 species were listed, 22 of these were added to the 1933 Washington Park list to make it 73.

1935 This season was very late and was really unusual as the cool weather continued well into June. The average temperatures for April and May, respectively, were 39.0° and 51.5°. The two highest readings were 65.0° and 60.0°, on May 10th and 14th. Some common species appeared to be rare, while, on the other hand, a good many of the usually uncommon birds were considerably in evidence. Fourteen trips taken between March 29th and May 19th resulted in the observation of 55 species of which nine were additional, increasing the park list to 82.

1936 This fairly early warm season had an average temperature of 44.3° in April and of 60.9° in May. Fifteen of the 20 trips taken between March 27th and May 19th were on days recorded as cloudy or partly cloudy, yet 72 species were recorded. Nine of these were new additions, bringing the total to 91.

1937 A fairly late season as it was cool until mid-April, then a sharp rise in temperature produced an average of 40.1° for April and of 52.3° for May. Less than half of the 26 mornings on which trips were made were called "clear." Five new records were included in the 80 birds seen and the total rose to 96. The greatest number observed on any day in the first five years of this study was 43 on May 16, 1937 (see pattern daily card on page 33). The 43d bird, the nighthawk, was observed later in the day and is not included on this pattern card.

1938 This very early warm season had average temperatures of 49.0°, 50.7°, and 61.1° in April, May and June, respectively. From an unusual 54.0° on March 24th, the temperature averaged high through the first week of May. Then although cool weather prevailed for ten days, the daily list varied between 37 and 52 species. The three highest numbers of 41, 44, and 52 species on May 9th, 14th, and 18th, were all recorded on clear days. The last of these, the largest daily list noted during the entire period of our study, included 13 warblers, the greatest number of the family of wood warblers recorded on one day. On 34 trips between March 24th and June 20th, we saw 83 kinds of birds including five new to the park list raising it to 101 species.

1939 The season was late with cold northerly winds evident in April and early May; average temperatures for these months were 43.5° and 51.6° respectively. On 28 trips between April 1st and June 17th, 80 species were observed of which five were additions; the total list became 106.

1940 This season was late. During part of this spring season the park lake was drained and for a short time only a few small water pools remained. This exposed lake bed attracted a few unusual visitors (see page 36). The average temperature for April was 42.5°, and for both May and June, 65.0°. Thirty-two trips taken between April 1st and June 14th produced a list of 87 forms, the highest for any one year; six of these records were new, bringing the total to 112 species.

1941 This season was normal, temperatures averaging 49.75°, 53.0° and 58.0° for April, May and June, respectively. There were a great number of clear mornings with few sharp drops in temperature and only a small amount of rain during April. A rather cool, early May was followed by normal weather. On 41 trips taken between April 1st and June 14th, 84 species were observed; of this number, four were additional to the total list making it 116.

1942 In this fairly early warm season with the usual three monthly averages at 48.3°, 62.2° and 60.0°, respectively, 32 trips were taken between April 4th and June 13th, and 82 forms were listed. Three of these were new records, increasing the total for the study to 119 species.

1943 A late wet season with few spring trips, but a number of late summer and fall trips produced a few fall records. One additional species, the eastern pigeon-hawk, was recorded on May 30th, bringing our total to 120 species.

1944 An early warm season with average temperatures of 45.5° and 64.5° for April and May. Ten trips were made from April 10th to May 6th (four of these in the latter month) and 60 species were observed. There were no new records, but several earlier first dates.

1945 The season started with cold weather in early March but this was followed by three weeks of warm, summerlike weather. The remainder of the vernal season was cool and rainy. These conditions produced a few early, and some late, "firsts"; scarcity of individuals especially of some of the common species prevailed. On 27 trips taken between March 18th and June 6th, 67 kinds of birds were observed; one addition, the whip-poor-will, was listed on May 15th; this made a grand total of 121 species.

1946 Unseasonably warm weather during the latter half of March brought a few earlier records of birds as did also the dry and rather cool April and early May. One additional species, the sharp-shinned hawk seen on April 18th, was included in the total list of 78 species observed on the 24 trips taken between March 28th and June 6th. The final total for the 14 years study became 122 species and subspecies.

GENERAL CHANGES IN OR NEAR THE PARK

Trimming of shrubs and trees in different years affected not only the number of individuals but also the number of species of wild birds recorded. In the spring of 1937, bushes in several sections of the park and particularly the Japanese quinces, east of the north end of the lake bridge, were pruned rather closely. As a result, cover was materially reduced and the number of small birds visiting these bushes was less than in the preceding two or three seasons when the drooping branches were longer. Cleanup of this sort adds to the attractiveness of this urban pleasure ground for the human visitors, but not for the birds.

On May 18, 1939, the senior author recorded the following: "The natural or former balance that prevailed among the animals in the park has been considerably disturbed even during the past six years we have been making bird records here. This is indicated by increase in number of: (1) gray squirrels, partly due to popular sentiment and feeding by park visitors; (2) starlings, with their pugnacity, belligerence and fecundity; (3) feral domestic pigeons; and (4) English sparrows. All were more abundant in 1939, than at any time since 1933."

Our records also indicated not only smaller numbers of various native birds that season but also a lower frequency with which they were observed.

The increased population of less desirable species resulted in a decrease in food supply for the native birds so while the latter continued to visit the park, they did not remain so long; on this account our chances of observing them were minimized.

Vegetation or lack of it in adjoining areas of the park also affects the wild life in the reservation itself. For many years, property on the east side of Thurlow terrace contained a tangled growth of herbs, shrubs and trees. Frequent observations during May in these unoccupied yards furnished many views at close range of thrushes, vireos, warblers and sparrows which also visited the park. A marked change was made in two of these yards in 1943 and 1944 when the outside fence was torn down from one place and the other lot was cleared and landscaped. The absence of the former enclosed, unmolested growth with its protective hiding places for timid wild birds, no doubt has had a marked effect on the number of species and individuals and their length of stay in the park itself.

DRAINAGE OF LAKE

The six-acre lake was drained and the bottom cleaned during the spring of 1940, primarily to destroy the growth of pondweed, (*Potamogeton crispus*), which had become abundant. The process of draining, cleaning and refilling occupied several weeks. For a time it took away the drinking and bathing water of the birds there and reduced temporarily the attractiveness of the area for certain species. Exposure of the lake bed brought in some strangers, however, and our greatest number of different kinds of birds, namely 87, was recorded this year.

The weather was fairly cold during March and early April. Some of the six inch snowfall of April 12th was still evident four days later. Soon afterward, workers started draining the lake and by April 27th only shallow pools remained. On May 1st, a ditch excavated down the center of the floor of the lake carried off the remaining water.

In early May, workmen began dumping earth on the lake floor in the west end and at certain points about the margins where the weeds had been removed. By May 11th, quick lime had been scattered over the moist floor and sides of the eastern third of the lake. While it was in this state, the grackles walked through the lime apparently without injury. One dead female grackle was found near-by, however, and one dead Virginia rail on Lake avenue which bounds the park on the west. Whether their death was due to the lime or some other cause, we were unable to determine. On May 17th, the lake was being refilled; the process took several days and we noted that the white lime was still plainly visible on its banks and floor when the water reached its usual height; apparently, however, the presence of the disinfectant had not been, and was not then, a deterrent so far as birds were concerned.

On various days, rusty blackbirds, killdeers, red-wings and semipalmated and solitary sandpipers were seen on the floor of the drained lake or about the small pools which appeared in it soon after draining. Evidently the changed conditions were an attraction for some species, for the two mentioned sandpipers and a Virginia rail made their only detected appearance in the park during this period.

DAYLIGHT SAVING TIME

Previous to April 25, 1937, Eastern Standard Time had been followed in Albany. Our trips in the park started about 5.45 a.m. before the day's traffic had well begun and lasted to about 7.15 a.m. The birds appeared to be little disturbed in this 90 minutes. But on Monday, April 26, 1937, at 6.45 a.m. Daylight Saving Time (5.45 E.S.T.) the birds were much quieter and fewer in numbers and species than on any of our preceding four visits of the year. Only 13 species were recorded by the two observers working separately. After 8.15 a.m., D.S.T., though many individuals were present in the trees they were relatively quiet and did not attract attention to themselves by voices. With the introduction of D.S.T., noisy traffic was noticeable an hour earlier and the birds reacted accordingly.

The conditions described for 1937 prevailed also in following years. We noted that city noises associated with the fast time made some differences in the bird population at our visiting hours in the park. In order to have consistent data, all of our subsequent records were kept in Eastern Standard Time.

MIGRATION

The arrival dates and numbers both of species and individuals varied in different years. In 1939 for instance, the migratory movement was long and drawn out. In 1941, there was an unusual prevalence of red crossbills, pine siskins, goldfinches and purple finches, while the warbler arrivals were distributed over an abnormally long period. Also in this year the white-throated sparrows came in a body in one night, providing on the following morning of May 5th, a thrilling experience when hundreds of them were heard and seen in one section of the park.

On May 13, 1942, we noted that it was a good warbler morning. An obvious movement of several species into this region had taken place in the past 24 hours, during part of which time a warm rain and a southerly wind had prevailed. Ten species of warblers were observed in less than two hours.

The migratory movement reached its peak yearly between May 13th and May 20th. The following table shows the numbers of species seen at the height of migration in 10 years.

Table 1

Height of migration according to largest numbers of species seen (highest number for each year italicized)

	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942
May 13.......	..	..	..	30	34	34	..	22	..	37
May 14.......	..	23	20	..	..	44	24	32	32	*39*
May 15.......	..	27	..	..	30	..	31	30	26	27
May 16.......	22	*29*	24	..	*43*	27	21	26	30	22
May 17.......	..	..	*27*	..	27	29	28	20	33	..
May 18.......	*24*	..	25	*33*	38	*52*	36	27	31	28
May 19.......	..	..	25	25	30	23	*39*	*37*	33	31
May 20.......	..	..	..	..	..	..	..	34	*42*	19

The manner in which warblers of several species congregate in one or a few closely grouped trees during migration is worthy of comment. Sometimes a veritable chorus of bird voices arises from one site while few are heard in near-by surrounding trees. Suddenly the fluttering and singing cease and in a few moments the birds have moved to a new center, there again to indulge in movement and song. Similar assembling and singing is noticeable also with goldfinches and some other species in the spring of the year. In fact, on certain mornings most of the individuals seem to be located in one section and few, if any, are seen or heard in other parts of the park.

The songs and call notes of certain species are dominant at different times. Late in April the myrtle warbler is heard frequently, and during early May the predominating voice in most of the park may be that of the purple finch, or of the goldfinch or one of the warblers or vireos. Later in May both the plaintive wood pewee and sibilant blackpoll warbler are often heard. Throughout most of the spring the grackles and starlings are the noisiest species. An early June morning produces a polyglot of bird voices, harsh, confusing, bewildering, sometimes almost obscuring those that the observer especially wishes to hear or upon which he is attempting to concentrate. Young and old starlings, English sparrows and grackles contribute most to this vocal bedlam.

Table 2

Relative frequency of occurrence of the 50 commonest species of Washington Park birds as indicated by the number of times seen on 250 early morning field trips each of one and one-half to two and one-half hours' duration and taken between the inclusive dates March 24 and June 20, seasons of 1933–42

	NAME OF BIRD	1933 (10 trips)	1934 (13 trips)	1935 (14 trips)	1936 (20 trips)	1937 (26 trips)	1938 (34 trips)	1939 (28 trips)	1940 (32 trips)	1941 (41 trips)	1942 (32 trips)	Total—250 trips
1	Dove, rock	10	13	14	20	26	34	28	32	41	32	250
2	Grackle, bronzed	10	13	14	20	26	34	28	32	41	32	250
3	Robin, eastern	10	13	14	20	26	34	28	32	41	32	250
4	Sparrow, English	10	13	14	20	26	34	28	32	41	32	250
5	Starling, common	10	13	14	20	26	34	28	32	41	32	250
6	Flicker, northern	9	11	10	19	23	34	27	28	37	30	228
7	Sparrow, eastern chipping	7	9	11	16	18	30	25	26	34	27	203
8	Woodpecker, northern downy	4	3	6	9	19	30	24	22	34	23	174
9	Cowbird, eastern	0	2	6	11	11	20	22	20	28	28	148
10	Sparrow, eastern song	5	1	13	17	25	28	16	4	18	14	141
11	Nuthatch, eastern white-breasted	1	4	0	4	12	31	25	17	22	22	138
12	Goldfinch, eastern	6	3	9	6	10	20	16	18	27	22	137
13	Sparrow, white-throated	5	8	4	14	10	21	15	15	25	17	134
14	Kinglet, eastern ruby-crowned	4	7	10	10	15	16	18	13	24	16	133
15	Vireo, eastern warbling	3	3	8	8	9	21	16	21	17	19	125
16	Warbler, eastern myrtle	4	3	2	12	10	15	15	11	23	15	110
17	Catbird	4	2	8	7	9	16	13	14	17	17	107
18	Oriole, Baltimore	1	3	7	5	8	17	16	17	16	16	106
19	Finch, eastern purple	0	2	5	7	4	18	14	12	24	14	100
20	Sapsucker, eastern yellow-bellied	3	2	5	5	12	9	14	16	20	10	96

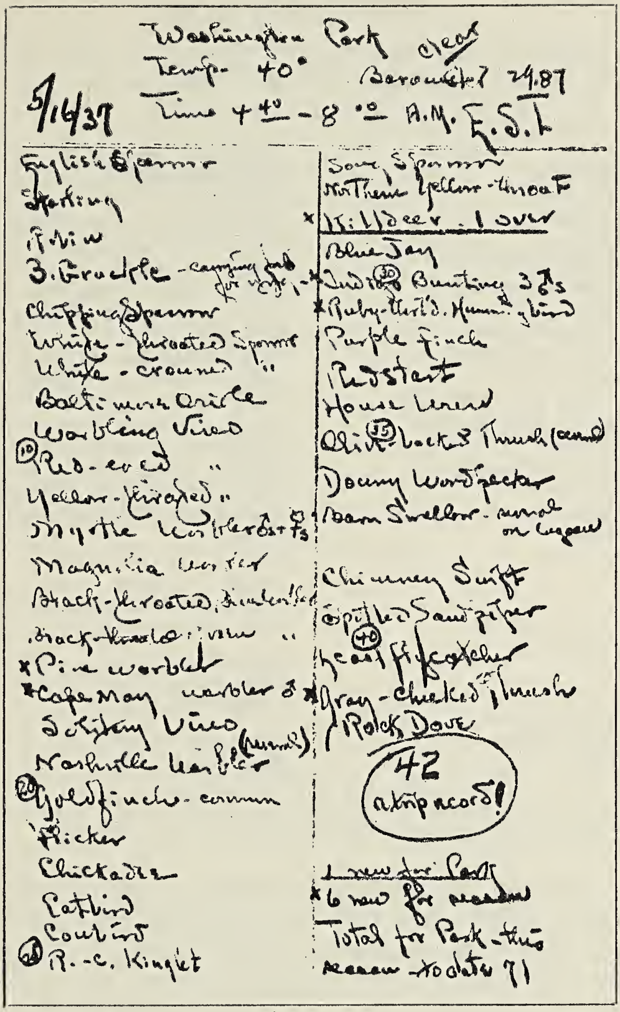
21	Swift, chimney	1	1	5	6	8	18	7	19	15	16	96
22	Junco, common slate-colored	4	7	3	10	9	11	3	11	16	14	88
23	Wren, eastern house	2	0	3	7	9	23	21	1	2	13	83
24	Vireo, yellow-throated	2	0	3	4	7	13	10	10	13	13	75
25	Red-wing, eastern	1	0	0	2	5	6	12	9	18	18	71
26	Crow, eastern	2	4	1	1	7	6	5	10	11	17	64
27	Vireo, red-eyed	1	3	2	4	7	10	7	12	9	3	61
28	Pewee, eastern wood	0	0	1	5	5	11	6	13	9	9	59
29	Vireo, blue-headed	0	0	0	7	3	8	10	5	18	5	56
30	Jay, northern blue	1	0	1	4	4	13	10	6	4	11	54
31	Thrush, wood	1	2	0	2	0	2	9	11	16	9	52
32	Chickadee, black-capped	2	1	0	0	15	11	1	1	0	16	47
33	Warbler, northern black-throated green	0	2	3	2	5	8	3	7	11	6	47
34	Yellow-throat, northern	1	2	4	1	6	10	2	5	9	7	47
35	Warbler, Nashville	0	1	3	1	7	11	5	7	7	4	46
36	Nuthatch, red-breasted	0	1	0	2	0	17	0	2	15	3	40
37	Flycatcher, least	1	0	4	3	2	5	4	1	7	10	37
38	Thrush, olive-backed	0	1	0	1	4	8	3	8	6	6	37
39	Creeper, northeastern brown	0	0	1	4	5	8	8	0	3	7	36
40	Thrush, eastern hermit	0	3	2	2	1	5	6	8	8	1	36
41	Warbler, magnolia	1	3	3	2	4	8	3	3	3	6	36
42	Oven-bird, common	2	2	1	4	1	5	3	4	6	4	32
43	Warbler, northern black-throated blue	1	1	2	0	6	6	1	2	6	7	32
44	Kingfisher, eastern belted	1	2	0	1	5	3	7	2	4	5	30
45	Sandpiper, spotted	1	0	0	1	5	7	3	7	4	3	30
46	Nighthawk, eastern	1	1	2	3	3	2	3	6	2	5	28
47	Warbler, chestnut-sided	0	3	3	2	2	6	3	1	5	2	27
48	Redstart, American	1	0	0	3	7	2	1	1	8	3	26
49	Warbler, black and white	0	1	1	5	3	4	4	1	5	2	26
50	Warbler, eastern yellow	0	0	7	2	5	2	1	2	2	5	26

RECORD OF TRIPS, LISTS AND CONDENSED TABLE OF OCCURRENCE

The 250 field trips of the 1933-42 study, which are charted in table 2, varied in length from one and one-half to two and one-half hours between 5 and 8 o'clock Eastern Standard Time. A few trips were three hours or longer. Field notes for each trip were kept on 3 by 5 cards, like that illustrated in figure 4. The date, temperature, barometric pressure, direction of wind and starting time were first recorded; the names of birds and other comments, such as whether individuals were seen either in or flying over the park, young in nest, etc., were added at the time of observation; the return time and total record for the day were written in as each trip ended.

While still fresh in the mind this information was transferred to two office notebooks by the senior author; one for detailed yearly tables like that for 1942 (page 36) and the other for the species accounts, varying in pages from one to 13 for each bird.

As 52 was the largest number of species that we recorded on one date, that list is here given in its entirety in the order seen on May 18, 1938. In the same year, the next longest list of 44 species was noted on May 14th (table 1, page 29); this was made on a two-hour trip from 4.45 to 6.45 a.m., E.S.T. on a clear morning with little wind and a temperature of 45°. On May 16th, while the temperature was 48°, it was cloudy, cold and windy and we noted that this type of weather had prevailed much of the time since May 9th. The coming of warmer weather by May 18th no doubt brought more species as well as greater numbers, and probably accounted for our longest list. In addition the clear, calm day materially aided observation.


Washington Park clear
Temp- 40° Barometer 29.87
5/14/37 Time 4 40 - 8 00 A.M. E.S.T.

English Sparrow
Starling
Robin
3. Grackle - carrying food for young
Chipping Sparrow
White-throated Sparrow
White-crowned "
Baltimore Oriole
Warbling Vireo
(10) Red-eyed "
Yellow-throated "
Myrtle Warbler
Magnolia Warbler
Black-throated [illegible]
[illegible] "
*Pine warbler
*Cape May warbler ♂
Solitary Vireo
Nashville Warbler (several)
(20) Goldfinch - common
Flicker
Chickadee
Catbird
Cowbird
(25) R.-c. Kinglet

Song Sparrow
Northern Yellow-throat
*Killdeer - 1 over
Blue Jay
*Indigo Bunting (30) 3 ♂s
*Ruby-throat'd. Humming bird
Purple Finch
Redstart
House Wren
(35) Olive-backed Thrush (common)
Downy Woodpecker
Barn Swallow - arrived on lagoon
Chimney Swift
Spotted Sandpiper
(40) Least Flycatcher
*Gray-cheeked Thrush
Rock Dove
42 a trip record!
1 new for Park
*6 new for season
Total for Park - this season to date 71

FIGURE 4 Reproduction of one of the original 3 x 5 field record cards made by the senior author. Over 300 similar cards were kept by each author in this 1933-46 study.

5/18/38

WASHINGTON PARK

Weather: clear

Temp.: 52°—Bar. 30.0″

Time: 4.45—7.15 a.m. E.S.T.

Starling
English sparrow
Baltimore oriole
Bronzed grackle
Myrtle warbler
Robin (young out of nest)
White-throated sparrow
Pine warbler
Yellow-throated vireo
Northern yellow-throat
Scarlet tanager
Black-throated green warbler
Black-throated blue warbler
Warbling vireo
Blue jay (1 in and 3 over)[1]
Red-eyed vireo
Wood pewee
Wood thrush
Least flycatcher
Flicker
Goldfinch
Chestnut-sided warbler
Chipping sparrow
Catbird
Brown thrasher
Tree swallow (1 over)
Olive-backed thrush
House wren
Nashville warbler
Spotted sandpiper (1)
Oven-bird
Bobolink (over-low-singing)
Red-breasted nuthatch
Magnolia warbler
Ruby-crowned kinglet
Black and white warbler
Chimney swift
White-breasted nuthatch
Rose-breasted grosbeak
Song sparrow
Cowbird (1 male, several females)
Ruby-throated hummingbird (1)
Downy woodpecker
Blackburnian warbler (1 female)
Black-crowned night heron (1 over low)
Veery
Canada warbler
Herring gull (1 immature over)
Rock dove or domestic pigeon (many)

Time: 8 to 9 a.m.
Slate-colored junco (1)
Redstart (1 female)

Time: 12.30 p.m.
Nighthawk

Total for day, 52 species

[1] The notation "in and over" means observed within the park or flying over.

Since the arrival time of birds varies from year to year and many of our trips in Washington Park were taken on the same day of the month, year after year, numbers of trips and species observed through the same seven dates for five consecutive years are given (table 3, page 35).

Table 3

A cumulative study of number of trips taken and of species of birds observed in Washington Park through the same seven dates in five seasons

	1938		1939		1940		1941		1942	
	Tr.[1]	Sp.[1]	Tr.	Sp.	Tr.	Sp.	Tr.	Sp.	Tr.	Sp.
April 1........	3	15	1	11	1	9	1	11	1[a]	12
April 30........	15	40	9	35	8	30	20	41	14	45
May 9........	21	62	14	48	14	51	27	63	20	69
May 11........	22	66	17	58	16	56	28	64	21	71
May 18........	28	78	23	74	22	74	34	76	27	81
May 30........	30	79	25	81	25	82	37	83	30	81
June 7........	34	81	27	81	30	87	40	84	31	82

[1]Tr.=Trips. Sp.=Species.
a—April 4 instead of April 1.

The above table shows not only the total number of different birds observed on each date, but it also shows that in between May 9th and 18th, which includes the height of migration period here in the Albany area, we had an average increase of 18 species.

Explanation of Table 4

Table 4 following, which contains our Washington Park 1933-41 composite records and 1942 detailed trip lists, is given as an aid to observers who wish to check appearances of different kinds of birds in this area. This table is given with the two parts of each section on opposite pages.

Part 1 of each section has the compilation of occurrences of each of 119 named species and subspecies checked in the first nine columns; all the remaining columns are checked for all April 1942 trips.

Part 2 of each section has the same named birds as in Part 1, with a detailed checking of all May and June 1942 records. For example, the Baltimore oriole is recorded every year 1933-41, but was not reported in April 1942 according to Section 2, Part 1. Part 2, however, shows it was seen on every trip May 4 to June 2, 1942, inclusive.

Total numbers of different birds recorded for each of nine years and for each 1942 trip are given at end of table 4. Early morning temperature for each 1942 spring trip appears immediately below totals.

TABLE 4

Alphabetical list of 119 different kinds of birds observed in the study of Washington Park, Albany, N. Y., seasons 1933-42, inclusive. Composite seasonal lists for 1933-41, with numbers of trips for each year, and detailed trip records of the total of 82 birds for April, May and June, 1942.

Section 1, Part 1

Name of Bird	1933 (10 trips)	1934 (13 trips)	1935 (14 trips)	1936 (20 trips)	1937 (26 trips)	1938 (34 trips)	1939 (28 trips)	1940 (32 trips)	1941 (41 trips)	1942 (14 trips) April 4	6	11	14	16	18	21	22	23	24	25	28	29	30
Blackbird, rusty	..	..	..	..	..	..	..	X	..	..	..	..	..	..	..	..	X	X	X	..	X	X	..
Bluebird, eastern	X	X	X	..	..	..	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bobolink	..	..	O	..	O	O	O	O	O	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Buffle-head	..	..	..	..	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bunting, indigo	..	..	X	..	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Catbird	X	X	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Chickadee, black-capped	X	X	..	..	X	X	X	X	..	..	X	..	..	..	X	X	X	X	X	X	X	..	X
Cowbird, eastern	..	X	X	X	X	X	X	X	X	..	..	..	X	X	X	X	X	X	X	X	X	X	X
Creeper, northeastern brown	..	..	X	X	X	X	X	..	X	..	..	X	X	X	X	X	..	..	..	X	X	..	..
Crossbill, red	..	..	..	..	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Crow, eastern	X	X	X	O	X	X	X	X	X	X	X	..	X	X	X	X	X	X	X	X	O	X	O
Cuckoo, black-billed	..	..	..	..	..	X	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cuckoo, eastern yellow-billed	..	..	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Dove, eastern mourning	..	O	..	..	X	X	O	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Dove, rock	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Duck, black	..	..	..	X	O	O	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Finch, eastern purple	..	X	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	X	X	X
Flicker, northern	X	X	X	X	X	X	X	X	X	X	X	..	X	X	X	X	X	X	X	X	X	X	X
Flycatcher, Acadian	..	..	..	..	..	X	..	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Flycatcher, least	X	..	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Flycatcher, northern crested	..	..	..	X	..	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Flycatcher, yellow-bellied	..	..	..	X	X	..	X	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Goldfinch, eastern	X	X	X	X	X	X	X	X	X	..	..	..	..	..	..	..	X	X	X	X	X	X	X
Goose, eastern Canada	..	..	O	..	..	..	..	O	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Section 1, Part 2

Name of Bird	1942 (16 trips) May																1942 (2 trips) June	
	1	2	4	5	6	8	11	12	13	14	15	16	18	19	20	30	3	13
Blackbird, rusty	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bluebird, eastern	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bobolink	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Buffle-head	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bunting, indigo	..	..	..	..	..	..	..	..	..	..	..	X	..	..	..	..	..	..
Catbird	..	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chickadee, black-capped	X	X	X	X	..	X	..	..	..	..	..	..	X	X	..	..	..	..
Cowbird, eastern	X	X	X	X	X	X	X	..	X	X	X	X	X	X	X	X	X	X
Creeper, northeastern brown	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Crossbill, red	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Crow, eastern	X	..	..	..	..	..	..	..	..	X	..	..	..	..	..	X	X	..
Cuckoo, black-billed	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cuckoo, eastern yellow-billed	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Dove, eastern mourning	..	..	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Dove, rock	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Duck, black	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Finch, eastern purple	X	X	X	X	X	X	X	..	X	X	X	..	..	X	..	..	..	..
Flicker, northern	X	X	X	X	X	X	X	..	X	X	X	X	X	X	X	X	X	X
Flycatcher, Acadian	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Flycatcher, least	X	..	X	X	..	X	..	..	X	X	X	X	X	X	..	..	..	..
Flycatcher, northern crested	..	..	..	..	..	..	..	..	..	X	..	..	..	..	..	X	..	..
Flycatcher, yellow-bellied	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Goldfinch, eastern	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	..	..	..
Goose, eastern Canada	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

X—Record of occurrence *in* the park.
O—Record of bird flying *over* the park.

TABLE 4 (*continued*)

Section 2, Part 1

Name of Bird	1933 (10 trips)	1934 (13 trips)	1935 (14 trips)	1936 (20 trips)	1937 (26 trips)	1938 (34 trips)	1939 (28 trips)	1940 (32 trips)	1941 (41 trips)	1942 (14 trips) April 4	6	11	14	16	18	21	22	23	24	25	28	29	30
Grackle, bronzed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Grosbeak, eastern evening	..	..	..	..	..	..	..	..	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..
Grosbeak, rose-breasted	X	X	..	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gull, American herring	..	..	O	O	O	O	..	..	..	..	..	..	..	..	..	..	..	O	..	..	..	..	..
Gull, ring-billed	..	..	..	..	..	O	O	O	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hawk, Cooper's	..	..	..	..	..	..	..	O	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hawk, eastern sparrow	X	X	..	X	X	X	X	X	X	..	..	..	X	..	..	..	..	..	..	..	..	..	..
Hawk, northern broad-winged	..	..	..	..	..	..	..	..	O	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Heron, eastern green	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	X	..	..	..	..
Heron, northern black-crowned night	..	O	O	O	O	O	O	O	O	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Heron, northeastern great blue	..	O	..	..	..	..	..	..	..	..	..	..	O	..	..	..	..	..	..	O	..	..	..
Humming bird, ruby-throated	X	..	X	..	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Jay, northern blue	X	..	X	X	X	X	X	X	X	..	..	..	X	..	..	..	X	..	..	X	..	..	..
Junco, common slate-colored	X	X	X	X	X	X	X	X	X	..	X	X	X	X	X	X	X	X	X	X	X	X	X
Killdeer, northern	..	..	..	..	O	..	..	X	O	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Kingbird, eastern	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Kingfisher, eastern belted	X	X	..	X	X	X	X	X	X	..	..	..	..	..	..	..	X	..	X	..	..	X	..
Kinglet, eastern golden-crowned	..	..	..	X	X	X	X	X	X	..	..	X	..	X	X	X	X	..	X	..	..	..	..
Kinglet, eastern ruby-crowned	X	X	X	X	X	X	X	X	X	..	..	..	..	X	X	X	X	X	X	X	X	X	X
Nighthawk, eastern	O	O	X	O	O	X	X	X	O	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nuthatch, eastern white-breasted	X	X	..	X	X	X	X	X	X	..	..	..	X	..	X	X	X	X	X	X	X	X	X
Nuthatch, red-breasted	..	X	..	X	..	X	..	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Oriole, Baltimore	X	X	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Oven-bird, common	X	X	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Owl, eastern screech	X	..	X	..	X	X	..	X	X	..	..	..	X	..	..	..	X	..	..	..	..	..	X
Owl, North American barn	..	..	..	O	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pewee, eastern wood	..	..	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pheasant, ring-necked	..	..	..	..	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Phoebe, eastern	..	X	X	X	X	..	X	..	X	X	..	X	X	..	..	..	X	..	..	X	..	..	..

Section 2, Part 2

Name of Bird	1942 (16 trips) May																1942 (2 trips) June	
	1	2	4	5	6	8	11	12	13	14	15	16	18	19	20	30	3	13
Grackle, bronzed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Grosbeak, eastern evening	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Grosbeak, rose-breasted	..	..	..	..	..	..	X	..	X	X	..	..	..	..	..	..	..	..
Gull, American herring	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gull, ring-billed	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hawk, Cooper's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hawk, eastern sparrow	..	..	..	..	..	X	..	..	X	..	..	X	..	..	..	..	..	X
Hawk, northern broad-winged	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Heron, eastern green	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Heron, northern black-crowned night	..	..	..	..	O	..	..	..	..	..	..	..	..	..	..	..	..	..
Heron, northeastern great blue	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Humming bird, ruby-throated	..	..	..	..	..	..	..	..	X	..	..	..	..	X	..	..	..	..
Jay, northern blue	X	X	..	X	X	..	X	..	X	X	..	..	..	..	..	X	..	..
Junco, common slate-colored	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Killdeer, northern	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Kingbird, eastern	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Kingfisher, eastern belted	..	..	X	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..
Kinglet, eastern golden-crowned	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Kinglet, eastern ruby-crowned	X	X	..	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..
Nighthawk, eastern	..	..	..	..	..	..	..	..	..	O	..	..	..	O	X	..	O	..
Nuthatch, eastern white-breasted	X	X	X	X	..	..	X	..	X	X	..	..	X	X	..	X	X	X
Nuthatch, red-breasted	..	..	..	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..
Oriole, Baltimore	..	..	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Oven-bird, common	..	..	X	..	..	X	..	..	X	X	..	..	..	..	..	..	..	..
Owl, eastern screech	..	..	..	X	..	..	..	..	..	..	X	..	..	..	..	..	..	..
Owl, North American barn	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pewee, eastern wood	..	..	..	..	..	..	..	..	..	X	X	X	X	X	X	X	X	X
Pheasant, ring-necked	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Phoebe, eastern	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

X—Record of occurrence *in* the park.
O—Record of bird flying *over* the park.

TABLE 4 (*continued*)

Section 3, Part 1

Name of Bird	1933 (10 trips)	1934 (13 trips)	1935 (14 trips)	1936 (20 trips)	1937 (26 trips)	1938 (34 trips)	1939 (28 trips)	1940 (32 trips)	1941 (41 trips)	1942 (14 trips) April 4	6	11	14	16	18	21	22	23	24	25	28	29	30
Rail, northern Virginia	..	..	..	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Redstart, American	X	..	..	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Red-wing, eastern	X	..	..	O	X	X	X	X	X	O	..	..	O	..	..	X	O	..	X	O	O	O	X
Robin, eastern	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sandpiper, eastern solitary	..	..	..	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sandpiper, semipalmated	..	..	..	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sandpiper, spotted	X	..	..	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sapsucker, eastern yellow-bellied	X	X	X	X	X	X	X	X	X	..	X	..	X	X	X	X	X	X	..	..	X	..	X
Siskin, northern pine	..	..	..	..	..	..	X	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sparrow, eastern chipping	X	X	X	X	X	X	X	X	X	..	..	..	..	..	X	X	X	X	X	X	X	X	X
Sparrow, eastern field	X	..	..	X	..	X	..	..	X	..	..	..	..	..	..	..	..	..	..	X	..	..	..
Sparrow, eastern fox	..	..	..	X	..	..	X	X	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..
Sparrow, eastern song	X	X	X	X	X	X	X	X	X	X	X	X	X	X	..	..	..	X	..	X	X	X	X
Sparrow, eastern swamp	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sparrow, eastern tree	..	..	X	..	..	..	..	..	X	..	..	X	..	..	..	..	..	..	..	..	..	..	..
Sparrow, eastern white-crowned	..	X	..	..	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sparrow, English	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sparrow, white-throated	X	X	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	X	..	X	X	X
Starling, common	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Swallow, American barn	..	..	O	X	X	..	O	O	..	..	..	..	..	..	..	..	O	..	..	..	..	X	..
Swallow, common bank	..	..	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Swallow, eastern cliff	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Swallow, northern rough-winged	..	..	..	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Swallow, tree	O	..	..	X	..	O	..	..	O	O	..	..	..	..	..	..	..	..	..	..	..	..	..
Swift, chimney	O	O	O	O	O	O	O	O	O	..	..	..	..	..	..	..	..	..	..	..	..	..	O
Tanager, eastern scarlet	X	..	..	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Thrasher, eastern brown	..	..	..	..	..	X	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Thrush, eastern hermit	..	X	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	X	..	..	..	..
Thrush, northern gray-cheeked	..	X	..	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Section 3, Part 2

Name of Bird	1942 (16 trips) May																1942 (2 trips) June	
	1	2	4	5	6	8	11	12	13	14	15	16	18	19	20	30	3	13
Rail, northern Virginia	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Redstart, American	..	..	..	..	..	..	..	..	X	X	..	..	..	..	..	..	X	..
Red-wing, eastern	X	O	..	..	X	O	X	..	..	..	X	..	O	..	X	..	O	..
Robin, eastern	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sandpiper, eastern solitary	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sandpiper, semipalmated	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sandpiper, spotted	..	..	..	..	..	X	..	..	..	X	..	..	X	..	..	..	..	..
Sapsucker, eastern yellow-bellied	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Siskin, northern pine	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sparrow, eastern chipping	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sparrow, eastern field	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	X
Sparrow, eastern fox	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sparrow, eastern song	X	X	X	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..
Sparrow, eastern swamp	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sparrow, eastern tree	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sparrow, eastern white-crowned	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sparrow, English	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sparrow, white-throated	X	X	X	X	X	X	X	X	X	X	X	..	X	X	..	..	..	..
Starling, common	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Swallow, American barn	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Swallow, common bank	..	..	..	..	..	..	..	..	..	..	..	..	O	..	..	..	..	..
Swallow, eastern cliff	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Swallow, northern rough-winged	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Swallow, tree	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Swift, chimney	..	O	O	O	O	O	..	..	O	O	O	O	O	O	O	O	O	O
Tanager, eastern scarlet	..	..	X	X	X	X	..	..	X	X	..	..	..	X	..	..	..	..
Thrasher, eastern brown	..	..	..	X	..	..	..	..	..	X	..	..	..	..	..	..	..	..
Thrush, eastern hermit	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Thrush, northern gray-cheeked	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

X—Record of occurrence *in* the park.
O—Record of bird flying *over* the park.

Table 4 (*continued*)

Section 4, Part 1

Name of Bird	1933 (10 trips)	1934 (13 trips)	1935 (14 trips)	1936 (20 trips)	1937 (26 trips)	1938 (34 trips)	1939 (28 trips)	1940 (32 trips)	1941 (41 trips)	1942 (14 trips) April 4	6	11	14	16	18	21	22	23	24	25	28	29	30
Thrush, olive-backed	..	X	..	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Thrush, wood	X	X	..	X	..	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Towhee, red-eyed	..	X	X	..	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Veery	..	X	..	X	..	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Vireo, blue-headed	..	..	..	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	X	..	..	X	X
Vireo, eastern warbling	X	X	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	X
Vireo, northern white-eyed	X	..	X	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Vireo, Philadelphia	..	..	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Vireo, red-eyed	X	X	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Vireo, yellow-throated	X	..	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, bay-breasted	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, black and white	..	X	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, Blackburnian	X	X	..	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, black-poll	..	X	..	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, Canada	..	..	..	X	..	X	..	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, Cape May	..	..	..	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, chestnut-sided	..	X	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, eastern myrtle	X	X	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	X	X	X
Warbler, eastern yellow	..	..	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, magnolia	X	X	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, mourning	..	..	..	..	..	X	..	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, Nashville	..	X	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, northern black-throated blue	X	X	X	..	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, northern black-throated green	..	X	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	X
Warbler, northern parula	..	X	X	..	X	..	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, northern pine	..	..	..	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, Tennessee	..	X	X	..	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, western palm	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	X	..
Warbler, Wilson's	X	..	..	..	X	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Section 4, Part 2

Name of Bird	1942 (16 trips) May																1942 (2 trips) June	
	1	2	4	5	6	8	11	12	13	14	15	16	18	19	20	30	3	13
Thrush, olive-backed	..	..	X	..	..	..	..	..	X	X	X	X	..	X	..	..	..	..
Thrush, wood	..	..	X	X	X	X	X	X	X	X	..	..	X	..	..	..	..	..
Towhee, red-eyed	..	..	..	..	X	..	..	X	..	..	..	..	..	..	..	..	..	..
Veery	..	..	..	..	..	X	..	..	..	..	..	..	..	X	..	..	..	..
Vireo, blue-headed	..	..	..	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..
Vireo, eastern warbling	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Vireo, northern white-eyed	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Vireo, Philadelphia	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Vireo, red-eyed	..	..	..	..	..	..	..	..	..	X	..	..	X	..	..	X	..	..
Vireo, yellow-throated	..	X	..	X	X	X	..	X	..	X	..	X	X	X	X	X	X	X
Warbler, bay-breasted	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, black and white	..	..	..	..	..	..	..	..	X	X	..	..	..	..	..	..	..	..
Warbler, Blackburnian	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, black-poll	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	X	..
Warbler, Canada	..	..	..	..	..	..	..	X	X	..	..	..	..	..	..	..	..	..
Warbler, Cape May	..	X	..	..	..	..	..	..	X	..	..	..	..	..	..	..	..	..
Warbler, chestnut-sided	..	..	X	..	..	..	..	..	X	..	..	..	..	..	..	..	..	..
Warbler, eastern myrtle	X	..	X	X	X	X	X	X	X	X	X	X	X	..	..	..	..	..
Warbler, eastern yellow	..	..	..	X	X	X	X	..	..	..	X	..	..	..	..	..	..	..
Warbler, magnolia	..	..	X	..	..	..	X	..	X	X	..	..	X	X	..	..	..	..
Warbler, mourning	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, Nashville	..	..	..	..	..	..	..	..	X	..	..	..	X	X	X	..	..	..
Warbler, northern black-throated blue	..	..	..	..	X	..	..	..	X	X	X	X	..	X	X	..	..	..
Warbler, northern black-throated green	..	..	X	..	X	..	X	..	..	X	..	..	..	X	..	..	..	..
Warbler, northern parula	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, northern pine	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, Tennessee	..	..	..	..	X	X	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, western palm	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Warbler, Wilson's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

X—Record of occurrence *in* the park.

TABLE 4 (*continued*)

Section 5, Part 1

Name of Bird	1933 (10 trips)	1934 (13 trips)	1935 (14 trips)	1936 (20 trips)	1937 (26 trips)	1938 (34 trips)	1939 (28 trips)	1940 (32 trips)	1941 (41 trips)	1942 (14 trips) April													
										4	6	11	14	16	18	21	22	23	24	25	28	29	30
Warbler, yellow palm	X	X	..	X	X	..	..	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Water-thrush, Louisiana	..	X	..	X	X	X	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Waxwing, cedar	X	..	..	..	X	X	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Woodpecker, eastern hairy	..	..	..	..	..	..	..	..	..	X	X	..	X	..	..	X	..	X	X	X	X	X	..
Woodpecker, northern downy	X	X	X	X	X	X	X	X	X	X	X	..	X	X	X	X	X	X	X	X	X	X	X
Woodpecker, northern pileated	..	..	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wren, eastern house	X	..	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Yellow-throat, northern	X	X	X	X	X	X	X	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Totals	51	57	55	72	80	83	80	87	84	13	14	11	22	15	17	19	24	20	24	23	24	25	26
Temperature in degrees, each trip in 1942	..	..	..	..	..	..	..	..	..	42	46	42	88	46	46	42	48	52	55	56	50	54	62

Section 5, Part 2

Name of Bird	1942 (16 trips) May																1942 (2 trips) June	
	1	2	4	5	6	8	11	12	13	14	15	16	18	19	20	30	3	13
Warbler, yellow palm	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Water-thrush, Louisiana	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Waxwing, cedar	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Woodpecker, eastern hairy	X	..	X	..	..	X	X	..	..	X	X	..	..	X	..	..	..	X
Woodpecker, northern downy	X	X	X	X	X	..	X	..	X	..	X	X	..	..	..	..	..	X
Woodpecker, northern pileated	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wren, eastern house	..	..	..	X	X	X	X	X	X	..	X	X	X	X	..	X	X	..
Yellow-throat, northern	..	..	..	..	..	..	X	X	X	X	X	..	..	..	..	..	X	X
Totals	24	24	33	32	32	33	29	18	37	39	27	23	28	31	19	20	22	20
Temperature in degrees, each trip in 1942	68	60	75	56	45	56	50	54	70	70	68	68	56	68	67	72	60	78

X—Record of occurrence *in* the park.

Note.—This total of 119 species and subspecies was increased to a total of 122 by the three following additions:

Hawk, eastern pigeon, May 30, 1943
Whip-poor-will, eastern, May 15, 1945
Hawk, common sharp-shinned, April 18, 1946

A list of Birds of Washington Park, the result of eight years work of three bird students, was published in The Birds of Albany County by Wilbur Webster Judd, 1907. Four species, namely, mockingbird, yellow-breasted chat, orchard oriole and vesper sparrow, of the 74 on that list, have not been observed by the present authors. We have seen, however, 52 additional species. Our 122 species plus the four recorded by Judd and one, the lesser scaup, by a reliable student (see page 10) now makes a total of 127 species and subspecies recorded for Washington Park.

ANNOTATED LIST OF BIRDS OF WASHINGTON PARK

ORDER CICONIIFORMES

Herons and Bitterns: Family Ardeidae

Northeastern Great Blue Heron*[1]

Ardea herodias herodias Linnaeus

Length 45 inches. The large size, general bluish gray coloration, lighter on the head, long black legs, and sharply pointed bill are distinguishing features. In common with other herons, the great blue heron in flight carries the head drawn back between the shoulders and the legs extended behind.

In the Albany region this bird, popularly though incorrectly known as the "blue crane," is a fairly common transient in both spring and fall; it may also breed in this area. It is our hardiest heron, winter stragglers being reported. The State Museum collections contain specimens taken in late December and February. Spring arrivals are likely to come in late March. In late summer adults and young often congregate about local shallow ponds and streams; this is the period of greatest abundance of the species. Few individuals remain after mid-October.

The large size, stately bearing, striking outline and majestic appearance in flight combine to center a great deal of human interest in the great blue heron. Its feeding and breeding activities are so definitely associated with marshy lowlands and swampy woodlands that its presence in Washington Park is almost accidental. The lake is not the type of water that normally appeals to this keen-sighted and wary bird. It probably flies over the park sufficiently low for positive identification more frequently than we have viewed it, but we have only three such records, namely, for April 20, 1934, and April 14th and 25th in 1942.

The great blue heron feeds principally upon fish and other aquatic and semiaquatic animals. Although sometimes persecuted by fishermen, most of the fish that it takes are not of sporting or commercial value. Moreover, it feeds to some extent upon forms of life destructive to young fishes. Evidence that gunners wantonly shoot this unique representative of our avifauna is presented by the occasional dead bodies one finds about frequently visited shooting grounds. Little excuse can be advanced for this killing which is both ill-advised and illegal. Every friend of wild life may well do his bit in discouraging this senseless slaughter.

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[1] The asterisk indicates the discussion of a species was prepared by the senior author; all others compiled by Mrs Stoner.

Eastern Green Heron* *Butorides virescens virescens* (Linnaeus)

Length 17 inches. Its small size for a heron, greenish black upper parts, chestnut neck and sides of head and short yellowish legs, together with the heron mode of flight as described for the great blue, are good field characters.

The green heron is our commonest representative of the family. The earliest spring arrivals appear about mid-April; practically all have departed for the south by mid-October. In summer this little heron is found along creeks and about wooded swamps and ponds throughout the capital district. It occurs even within the city limits of Albany, less than two miles air-line west of Washington Park, where its hoarse *"skeow"* of alarm is almost sure to greet the human intruder upon its breeding or feeding territory. Of all our herons, this species exhibits the greatest tendency to visit the vicinity of, and sometimes nest near, human habitations.

Despite these inclinations, however, we have observed the green heron in Washington Park on only five occasions. On the warm afternoon of May 15, 1937, a single individual made a striking picture as it stood on the grassy northwest shore of the lake. Within a few minutes it flew into a near-by tree, then back to the shore for a few moments, then disappeared westward. Two birds were in the park on April 24, 1942. One alighted momentarily in a tree just northwest of the lake house but almost immediately it perceived the observer and accompanied by another individual, which had not previously been seen, flew westward over the lake and out of the park.

At dusk at 8 o'clock in the evening of August 29, 1943, a single individual with weak, vacillating flight fluttered into the protection of tall bushes on the south side of the lake across from the lake house. It was evidently stopping there for the night. This is both the first autumnal and first evening record for this species.

On the morning of May 4, 1944, we observed one green heron flying low, going east, the length of the lake; the bird had evidently just arisen in flight from the west end of the lake. April 23, 1946, was our earliest date for this species when we saw one individual flying over the park.

The lack of reedy swamp areas about the lake renders unlikely the more than casual presence of the green heron in the park; careful scanning of the sky overhead in April and May, however, could possibly reveal an occasional bird flying over sufficiently low for positive identification.

FIGURE 5 Looking west over the lake on a quiet May morning. The trees by the lake house and those on the shore attract birds. May 31, 1938

FIGURE 6 A central view of Washington Park showing horse-chestnut tree in full bloom. A scarlet tanager was observed in this tree on this date. May 14, 1941

FIGURE 7 A bushy nook affording retreat for catbirds, white-throated sparrows and northern yellow-throats. One record for the rare mourning warbler was obtained at this spot. May 31, 1938

The food of the green heron consists principally of small aquatic animals and it, too, has incurred the ill will of fishermen and sportsmen because of its destruction of fingerling trout in streams and artificial ponds. The bird takes many crawfish and large aquatic insects, however, some of which are, in turn, enemies of small trout. In the end, therefore, as far as man is concerned, the beneficial qualities of the "little green" at least balance its detrimental habits.

Northern Black-crowned Night Heron*

Nycticorax nycticorax hoactli (Gmelin)

Length 24 inches. Adults with greenish black back and crown, wings gray, forehead, lores, neck and underparts white; bill black; legs and feet yellow. In the breeding plumage, two or three white plumes some six inches long depend from the back of the head. The plumage of immature birds is brown streaked with white. The deliberate wing beats and hoarse *"quock,"* often uttered in flight, are good field characters.

Although perhaps not so commonly seen in the capital district as the great blue or green herons, the black-crowned night heron is probably the most numerous of the three in this territory. This seeming anomaly is explained by the fact that the night heron nests in colonies, and as a rule moves into surrounding territory only in the morning before sunrise and in the evening from near sunset until well after dark.

The black-crowned night heron or "quock" is a transient and a common summer resident. Usually first arrivals appear late in March or early in April; from then until late September this bird is a conspicuous member of our bird population, particularly in the vicinity of wooded swamps and streams. In open winters stragglers sometimes occur but cold weather so inactivates this heron's food supply, consisting mostly of small aquatic and semiaquatic vertebrates and larger invertebrates, that getting sufficient food under such conditions is exceedingly difficult.

Although we have no records for the black-crowned night heron in the park, we have positively identified it flying over, sometimes very low, every season except that of 1933. There was some indication that the bird was becoming more common for each spring between 1938 and 1943, except 1942, it was listed on at least three field trips, while previous to 1938, we noted it on not more than one trip each season.

Our earliest spring record is May 2, 1938. Fourteen of our 27 sight records are for May, 12 are for June and one for July, while other summer dates could be cited. Quite often the birds have occurred singly or in pairs; again at other times, several individuals have been observed together. Most of the morning records are for birds flying in a southerly or southeasterly direction, while in the majority of evening observations the herons were going in a northerly or northwesterly direction.

Although the black-crowned night heron occurs not infrequently at Buckingham lake and at a wooded pond both near the western outskirts of Albany, the nearest local breeding colony, at least of any size, was for an extended period located in the Normandin woods on the west side of the Mohawk river about three miles south of Crescent and 10 miles northwest of Albany as the heron flies. Here for years between 300 and 400 individuals usually nested in a well-circumscribed rookery. A diminution of the number of individuals was noted after the 1935 season and in June 1942 this colony was apparently broken up. Other smaller rookeries not too distant along the Mohawk now survive. Most of the crude twig nests occupy apparently precarious positions well toward the tops of tall slender trees in swampy woodland. The birds take up their territory in early April and from then on through the summer their goings and comings are concerned mainly with nest-building activities and the gathering of food for themselves and their young. It is on these feeding forays that the herons are most likely to be noted flying over Washington Park. Some of the birds appear to feed along the tidal flats of the Hudson south of Albany and return to the rookery to attend family duties or simply to roost. A visit to a rookery in May or June would well repay the observer for the insight he may obtain into the social behavior, nest building and feeding activities, as well as the general natural history of this interesting, largely nocturnal heron. If he visits it when young are in the nest, the bedlam of voices, the number of dead or decaying young which have fallen from the nest to the ground and the overpowering fishy odor will not fail to impress him.

Washington Park visitors, even without the aid of field glasses, may identify the black-crowned night heron flying over at twilight, especially during summer months, if they notice that, for a heron, this is a short-necked, short-legged stockily-built bird which has a manner of flight similar to that of a gull, and that powerful wing strokes carry it along in a strong direct flight.

ORDER ANSERIFORMES

Ducks, Geese and Swans: Family Anatidae

Eastern Canada Goose*

Branta canadensis canadensis (Linnaeus)

Length 40 inches. Grayish brown above with black head and neck; underparts grayish to whitish. The large size, black head and neck, white cheek patches and unusual V-shaped flight formation are good field characters. The birds usually repeat a sonorous *"honk"* as they fly along.

Without doubt in both spring and fall considerable numbers of Canada geese fly over the park low enough to be identified with certainty. On only three occasions, however, have we been fortunate enough actually to observe the species. On May 8, 1935, a large bird flying west at a good height was provisionally determined as a Canada goose; and on the morning of April 25, 1940, a flock of 10 individuals in V-formation flew directly over the park in a northerly direction and at an apparent height of 500 to 600 feet. Two V-formations were seen flying northwest at 10 a.m. on April 17, 1943, by the junior author. Twelve individuals were counted on one side of the larger V up to the center point, making a total of 25 in this group. Thirteen were in the smaller V-formation, and a few scattered birds were noted, so that the total was more than 40. They attracted attention as they were noisy and flying low over the northwest corner of the park. Suitable habitat for this bird is lacking in the park so its occurrence there is extremely unlikely. Few harbingers of spring, however, are more characteristic or generally recognized, and sharp sky-watching from the park area should yield an occasional record.

Black Duck* *Anas rubripes* Brewster

Length 22 inches. General color dark brown; feathers paler, edged with buffy; head and neck streaked and darker; patch on wing (speculum) purple, bordered with black and narrowly tipped with white; wing linings whitish, conspicuous in flight.

Here the term "wild duck" usually refers to this locally abundant transient and fairly common summer resident; occasionally, too, it occurs in the Albany region in winter. The principal local migratory flyway is, of course, the Hudson river, while the most important nesting area is in the flag-grown, swampy flats along the north side of the Mohawk river about 15 miles northwest of Albany. Sometimes the birds take a short cut from some point in the river south of Albany to these or other feeding and nesting places and in so doing pass over the park. Although we have only one actual sight record for the black duck in the park, it is said that occasionally a wounded or exhausted individual has found refuge on the lake there. In fact, our sight records of this duck flying over the park are not many and are for mid-May and early June; on these occasions only stragglers were seen moving in a westerly or northwesterly direction. Without doubt, however, flights of much greater proportion occur over the park at night and probably also during the first hours of daylight and again at evening, for it is at these times that the bird is most active. Flocks are most likely to be seen in spring between early March and mid-May and in autumn between mid-August and mid-November.

Buffle-head* *Bucephala albeola* (Linnaeus)

Length 14 inches. Male with feathers of head and neck lengthened, greenish with bronzy reflections; a broad white band extends over back of head behind the eyes; back black, underparts white. Female with a white patch on either side of head, above brownish, below white. Speculum white in both sexes. The small size, white markings on the head and the white wing patch are distinctive field characters.

This little duck occurs uncommonly in the Albany region and only as a transient. It is most likely to be observed from late March to about May 1st and again in autumn from mid-October through November. In the east the buffle-head breeds mainly in Canada and winters from Maine to Florida and Texas.

It was with no little surprise and considerable satisfaction, that the senior author, early on the morning of April 22, 1941, discovered a female buffle-head on the waters of the park lake, west of the bridge. The bird permitted him to approach within 30 yards while it swam calmly about. As he continued his quest for other species on his way around the lake, he saw the buffle-head dive at intervals as if in search of food. Two or three times it essayed short, low flights, once coming to rest from one of these flights within 20 feet of him. The bird appeared to be altogether poised, unhurried and not in the least frightened. Although he could not be sure, the buffle-head appeared to be uninjured. The author had some doubt on this point, though, for while the duck could fly, he was not certain that, because of perhaps minor injuries or exhaustion, its flight ability might have been so restricted as to prevent it from undertaking protracted flight.

FIGURE 8 Looking south at the east end of the park near Willett street. In centered foreground State Street end of Knox Street path which is aligned by tall elms. These trees attracted screech owls, warblers and other birds. March 21, 1938

FIGURE 9 North side of Washington Park looking west along State street from roof of building near northeast corner of the park where bronzed grackles later nest in the row of white pines. April 21, 1938

FIGURE 10 East end of white pines at Northern Boulevard and State Street entrance of park. Snow on ground when first bronzed grackles arrived on this date. March 21, 1940

FIGURE 11 An open sunny spot near State street, northern limit of Washington Park. May 4, 1938

For more than an hour the buffle-head continued to rest and feed and occasionally to engage in short flights over the water. It was still on the lake at 7.30 a.m. Other observers reported its presence there at 10 a.m. and on returning to the park at 6.30 p.m. the senior author found it in the same section of the lake as in the morning. By the following morning, April 23d, the duck had disappeared. Evidently it had settled on this small body of water during one night or early morning and had resumed its northerly journey during the next similar period. The species can be considered only of occasional occurrence in Washington Park.

In spring the buffle-head is most likely to be seen in pairs or small flocks on ponds, lakes and reservoirs. It is usually rather shy and depends largely upon its extraordinary diving ability and underwater locomotion to escape danger. In these activities it is almost as expert as the grebes. Ordinarily it flies with rapid wing beats and great speed a few feet above the water. It alights with a considerable splash and glides along the surface for some distance before the braking action of its feet, which in this effort are directed forward, proves effective in bringing the bird to a stop. While this active little species often occurs along with other ducks, it does not generally associate with them.

Among gunners this duck is often called "butter-ball" or "butter-box" on account of the thick layer of fat which envelops the body. The usually "fishy" flavor of its flesh renders it undesirable for the table.

According to Cottam (1939, p. 68-73) the animal food of the buffle-head, 79 per cent of its diet, consists principally of insects, crustaceans, mollusks and fishes. About 21 per cent of the bird's subsistence is plant materials. Most of its food is obtained by diving in water ranging in depths from four to 15 feet.

ORDER FALCONIFORMES

Hawks, Eagles Etc.: Family Accipitriidae

Common Sharp-shinned Hawk

Accipiter striatus velox (Wilson)

Length about 12 inches. Bluish gray above, primaries barred with blackish; tail long and squarish with four black crossbars. Below barred with pale rufous; wings short and rounded.

One individual of this rather common species was seen flying over the northwest corner of the park on the morning of April 18, 1946, by the junior author. The bird was gliding or sailing and observed only in a brief interval; by means of binoculars, however, the bands on the long tail were noticeable and the rather short rounded wings were plainly visible as the bird turned about a couple of times in a very small circle before flying off in a northerly direction. Chapman (1932, p. 218) says, "Sometimes it may be seen soaring in narrow circles, when its disproportionately long tail forms a good field character." About two weeks previous to this, the same observer had seen the sharp-shinned hawk in the country about 12 miles southwest of Albany.

This species is easily confused with Cooper's hawk; however the latter species is larger and has a rounded tail while the sharp-shin, according to Peterson (1947, p. 60) has "a square-tipped tail (slightly forked when folded)." It is almost the size of the sparrow and pigeon hawks, but these two species have long pointed wings. As usual in birds of prey the male is smaller than the female.

The sharp-shin, which is not commonly seen over city areas, is sometimes called "chicken hawk" or "pigeon hawk." Determination of the kind of food as shown by the examination of stomach contents is given by Fisher (1893, p. 37): "Of 159 stomachs examined, six contained poultry or game birds; 99, other birds; six, mice; five, insects; and 52 were empty."

Cooper's Hawk* *Accipiter cooperii* (Bonaparte)

Length 17 inches. Upper parts slaty gray with the crown blackish; underparts whitish, barred with reddish brown or buffy; principal wing feathers and tail feathers barred with blackish. Its larger size, by about five inches, and its rounded tail distinguish it from the sharp-shinned hawk; and these features together with the shorter, rounder wings differentiate it from the sharp-winged sparrow and pigeon hawks.

Cooper's hawk is an active, aggressive and destructive species of which we have noted only a single example flying in an easterly direction, low over the trees on April 27, 1940. Its preference for wooded situations, not too distant from a likely source of food supply, precludes the likelihood of more than irregular or accidental presence in the park. Although this hawk nests in the Albany area, it is likely to be noted about such places as Washington Park only during its spring movement in March and April and possibly again in September and October.

The appellation, "chicken hawk," is properly applicable only to this species and its close relatives, the sharp-shinned hawk and the goshawk, which also occur in this territory. In addition to domesticated birds of various kinds, Cooper's hawk takes many kinds of wild birds.

Most of the stomachs examined by the United States Fish and Wildlife Service (formerly the Biological Survey) that have contained anything, held remains of birds. "Of 133 stomachs examined, 34 contained poultry or game birds; 52, other birds; 11, mammals; one, frog; three, lizards; two, insects; and 39 were empty." (Fisher, 1893, p. 43.)

While the toll that this hawk exacts from other birds is partly offset by the insects that it takes, Cooper's hawk can scarcely be acclaimed as a desirable species as far as its relation to man is concerned. On the other hand, neither this hawk nor any other should be uncompromisingly condemned for they all have a part in maintaining Nature's balance. The anthropocentric viewpoint with reference to this, as well as other species of animals whose habits we too frequently disparage, can well be modified.

Northern Broad-winged Hawk*

Buteo platypterus platypterus (Vieillot)

Length about 16 inches. Above dark grayish brown; tail short, in flight often carried widely spread, thus displaying the broad black bars separated by almost equally wide white bars. Below barred with reddish brown and white. A short, heavy-bodied, round-winged, barred-tailed bird.

This woodland-loving hawk is a transient in the Albany region during April and May and again in the late summer and early autumn. Migration flights, comprising two or three birds to intermittently appearing loose flocks over a period of several days, often characterize the spring and autumnal movements of the broad-winged hawk. In this State the bird appears to be commonest in the Adirondacks region where it nests. Mixed and hardwood forests are its favorite habitats. The broad-wing sometimes spends the winter in the warmer parts of the State.

Undoubtedly the broad-winged hawk occasionally, perhaps even frequently, flies over Washington Park in its migratory journeys. It was not until April 21, 1941, however, that we noted it. On the early morning of that day, three individuals were circling about the west end of the park at an estimated height of 250 feet. The prevailing winds, in this case southerly, and the sailing manner of flight soon carried the hawks out of sight toward the north. The low altitude at which they were flying permitted a good view with the binoculars and provided a reasonable opportunity to see the outstanding field characters.

The broad-wing is primarily a bird of the forests and with the depletion of original and mature stands, it has resorted to the heavier forests still remaining in the more populous regions and to those in the Adirondacks. In the light of our experience, sight of it from Washington Park can scarcely be hoped for regularly.

The broad-wing feeds on frogs, toads, snakes, crayfish and the larger insects. Among the latter are grasshoppers, crickets and white grubs. Small mammals such as mice and shrews, and occasionally small birds, are sometimes taken. On the whole, the habits of this hawk are open to no serious criticism as far as man is concerned. This hawk can well be spared to add life and the spirit of the wild to our rapidly disappearing deep forests.

Caracaras and Falcons: Family Falconidae

Eastern Pigeon Hawk *Falco columbarius columbarius* Linnaeus

Length about 11 inches. Male, above bluish gray, primaries barred with white; tail with three or four whitish bars, and tip white; breast buffy streaked with black; wings pointed, flight swift and dashing.

This rare transient was recorded only once by us, on May 30, 1943. One individual was seen flying low over the park pursued by a couple of chimney swifts. We watched it at 11 o'clock in the morning from the roof of a nine-story apartment building and saw it soar round and round. Then later it settled down some blocks away. In a few minutes the bird returned and again circled over the same building before flying swiftly away to the northwest. The manner of flight and coloration were noted in particular to identify the bird with certainty. Judd (1907) does not include this species in his list of Birds of Washington Park, but Caduc records it on May 22, 1915, in a pencilled list of additions to Judd's list.

The pigeon hawk, about the same size as the sparrow hawk, is more frequently seen in the open country or along edges of woods or shores of large bodies of water, rather than about a park in the heart of a city.

Eastern Sparrow Hawk *Falco sparverius sparverius* Linnaeus

Length, male, 9 to 10.5 inches; female, 9 to 12 inches; our smallest hawk. Male with rufous upper parts barred with black; wings grayish blue, more or less spotted with black; tail rufous with subterminal broad black band, the tip white; a black mark behind and before the white ear coverts; underparts white to pale rufous, more or less spotted with black. Female, similar but with back, wings (without grayish blue color) and tail more yellowish brown and heavily barred with black. Wings pointed, flight falconlike, interrupted by sailing and hovering; a common cry is *"killy, killy, killy."*

The small size for a hawk, erect posture when perching, narrow, pointed wings, the peculiar flight of several rapid strokes alternating with a short sail and, on occasions, hovering, are good field characters for this resident.

We have seen and heard the sparrow hawk in, near, or flying over, the park every month of the year. We doubt whether the bird is becoming more common in the park area as we surmise that our sight records involve the same individuals in a given season, at least from the beginning of the breeding period through summer. It is of interest to note that on our early morning trips taken in the spring and early summer of 1933, 1934, 1936 and 1938, we saw the sparrow hawk on only one occasion each season; in 1940 and 1939, we saw it on two and seven trips respectively, while in each of 1941 and 1942, we recorded it on five trips. The sparrow hawk had been seen about Northern boulevard and State street at frequent intervals early in 1942, but the definite dates of April 14th, May 8th, 13th, 16th and June 13th suggest a possible nesting in or near the park. Evidence is not at hand to prove that it nests within the park boundaries, although some of the old, partly decayed and hollow trees there offer suitable nesting sites.

In 1946, however, a pair did successfully nest across the street from the southwest corner of the park. Their domicile was in the rear at the junction of two apartment buildings, each two stories high. It was located about 45 feet from the ground with an entrance about three inches wide and six inches high between the cornices of the two houses. The nest was not visible but droppings on buildings immediately below gave evidence of the adults' many visits there. The pair first attracted the attention of some friends living on Madison avenue on about April 10, 1946, as the birds were seated close together on a limb of a maple tree, 50 feet from the ground, but on a level with and only ten feet distant from their third floor apartment window. For long periods on several days the birds remained perched thus, contentedly chattering and preening themselves. Then for a time the male would be seen there alone for hours while the female would disappear and reappear. Beginning about May 10th in the morning and evening hours, which were our friends' best periods of observation, the female would fly into the neighborhood shrieking and usually bearing a mouse in her right claw.

On the evening of May 12th at 6 o'clock the junior author witnessed their performance. The female, with a mouse, flew first to the male who sat stolidly in the rain, except for softly uttered chatterings and preenings, on the usual tree limb; then she became frightened by observers at the window and flew to another favorite resting spot, the top of a telephone post. Here she played with the small rodent for a period before flying up over the nesting site as if to go to the park.

Almost daily in the next couple of weeks these watchers observed the female with an animal. Sometimes when disturbed she flew over the two-story building to a near-by park tree, but usually after partly tearing the animal (in two instances an English sparrow and in one a small mammal, either a mole or a shrew) she would fly in the same direction apparently to feed the young in the nest. Twice she flew down to a small grape arbor and came up almost immediately with a mouse (probably the common house mouse) in her claw. The observers sometimes noticed that the mouse had a long tail and was a different color from the regular house mouse. This small mammal may have been some species of the jumping mouse. A small open field of uncut grass, a suitable habitat for the jumping mouse, is located about a block south of the nest locality. The male was seen to bring in a few mice but up to June 1st he maintained his post more or less regularly on about the same limb in the near-by maple tree. From then on he, too, was more active.

On the afternoon of June 5th, a young bird was seen out of the nest by one of the apartment dwellers; for about two hours it moved at intervals back and forth on top of a ten-foot fence. In the evening the juvenile was noticed up in the same maple tree that the parent had so often previously occupied. The young bird now 50 feet up from the ground flew against one of the third floor window screens while our friends were watching, but when unable to get a hold in the screening, it dropped directly to a near-by tree limb for perching. The observers had good opportunities to see how light colored (almost white) the legs and beak were as compared with those of the adults.

By June 7th the three young (two females and one male by coloration) were out of the nest, and the adults were kept busy feeding them in various locations which were on top of the house or in another near-by maple tree or on top of a telephone pole. When the young were 15 or more feet up from the ground, neither they nor the parents seemed timid of observers. Nor did the other birds, English sparrows or robins, appear to disturb them. A catch of at least 70 mice was actually noted in the morning and evening observations; no doubt if a full-time count had been made this number would have been multiplied several times. From man's point of view this illustrates a beneficial habit of this attractive looking hawk. The adaptability of this species both in food and nesting site is well-illustrated by this pair; it seemed that the female must have done practically all the incubating and most of the feeding of the young while they were in the nest.

Bent (1937, p. 110) says, "The sparrow hawk lays, ordinarily, four or five eggs, occasionally, only three and very rarely, six or even seven." Sherman (1913) gives the incubation period as from 29 to 35 days and that of young in the nest as 26 or 27 days. Accordingly we estimate that the eggs for this nesting pair must have been deposited about April 8th to 12th and that they probably hatched about May 10th or 11th (when the female was first seen carrying mice). One young was first noticed out of the nest on June 5th. By June 11th, the young, two females and one male, resembled the adults in plumage and size. They could be identified easily by their lesser skill in perching and especially by their being fed by the parents, who poked huge pieces of mice or other food down their throats.

All during the winter the sparrow hawks are observed, frequently at the northeast corner of the Education Building and about the State street side of the park, where they make sorties upon flocks of English sparrows and starlings. As a species this hawk is migratory in the Albany region and individuals observed here in winter may be summer residents of more northerly sections. Usually only one or two of these hawks have been seen in or about the park at any one time; but on April 26, 1938, three individuals appeared over the treetops uttering their characteristic, shrill *"killy-killy"* as they flew along apparently fighting among themselves. Probably these antics were connected with mating. On May 12, 1939, and on various April dates we noted pairs in copula. During April or early May, the species is most likely to be observed in pairs.

This little falcon is sometimes called "killy-hawk" from the oft-repeated cry just noted. It has also been termed as "grasshopper hawk" because of its habit of feeding upon those insects which, together with crickets, beetles and caterpillars, comprise more than half of its food. Spiders, mice and other small forms of life constitute the remainder of the bird's diet. English sparrows, juncos and other native sparrows and small birds are sometimes eaten when the supply of larger insects has become reduced. The senior author saw a sparrow hawk swoop down (unsuccessfully) upon a flock of juncos in the park and on May 9, 1939, found the freshly decapitated and otherwise mutilated body of a robin near the foot of one of the large elms. Circumstantial evidence pointed to a female sparrow hawk as the executioner.

A notation which he made on the feeding habits of this bird in the park and which was first recorded in *The Auk* (Stoner, 1939) may well be given here.

> "About 6.30 o'clock (Eastern Daylight Time), on the morning of May 5, 1939, while observing birds in Washington Park in the heart of the city of Albany, New York, my attention was drawn to a female eastern sparrow hawk (*Falco s. sparverius*) perched high up in a large elm. As I watched, the bird, evidently unaware of my presence, suddenly darted from its vantage point to the trunk of an adjacent tree of similar kind and size, seized and carried away what appeared through the binoculars to be a small bat. The color of the victim, its shape and a brief view of the tip of a weakly flapping wing afforded the bits of evidence for my first and provisional diagnosis.
>
> "On following the flight of the hawk it was observed to alight well out on the limb of another elm, about 50 feet above the ground, where at once it began vehemently and greedily to devour the prey. The first struggles of the victim, manifest principally in the flapping of one wing, soon subsided as the hawk continued to tear it to pieces. Perhaps two minutes elapsed before the bird had finished the meal. As I continued to watch these proceedings through the binoculars, I wished that some way might be found to determine definitely on just what the hawk was feeding. Then, as though in answer to this thought, it arose in flight and in so doing dropped from its claws a fragment of the prey. Upon examination this proved to be the facial portion of the head of a big brown bat, *Eptesicus fuscus*. Although the brain case had been removed by the hawk, the furred facial skin, the intact left ear and the complete dentition provided sufficient evidence for positive identification of the bat. All the other parts of the animal had apparently been eaten by the hawk.
>
> "I have never before observed this feeding habit of the eastern sparrow hawk and so far as I have been able to ascertain, records of the occurrence of this or any other bat in the stomachs of sparrow hawks appear to be very rare."

Another capture was recorded thus: "On May 10, 1941, an adult seized a small bird, probably an English sparrow feeding in the top of a tall elm and bore the struggling and loudly crying victim in its claws toward the northwest section of the park. The hawk itself added its shrill cries to those of the victim in the excitement of the moment."

Despite its tendency now and then to take a song bird, the sparrow hawk must be given a highly beneficial rating from an economic as well as an esthetic viewpoint.

FIGURE 12 West end of white pines along State street where the grackles rest in the trees rather than on the snow-covered lawn. March 21, 1940

FIGURE 13 Larch trees in center background attract goldfinches and warblers. Crossbills and pine siskins fed on buds of these trees in 1941. The near-by dwelling house on Englewood place marks the north edge of this section of the park. May 15, 1939

FIGURE 14 Quiet water, blooming forsythia, budding maples and a bright sun invite both birds and observers. April 21, 1938

ORDER GALLIFORMES

Pheasants: Family Phasianidae

Ring-necked Pheasant* *Phasianus colchicus torquatus* (Gmelin)

Length of male, 34 inches; female, 20 inches. Male, above ground color, deep chestnut-red with yellowish markings; rump grayish green; head and neck green, face red; a conspicuous, white, almost complete neck ring; below lustrous bronze-red, feathers more or less black-tipped; tail with numerous black crossbars, long, streaming, pointed and folded. Female, above mottled with black, brown and yellowish; below, yellowish brown, the sides and flanks brownish black; tail shorter, but barred and pointed.

After eight seasons of observation on the birds of Washington Park without having recorded this large, well-known, introduced form there, it was somewhat of a surprise to come suddenly upon a fine male early in the morning of April 2, 1941. The pheasant was first observed unconcernedly walking across a park road in a little valley just west of the old refectory. As soon as it discerned the observer it began running swiftly westward across the lawn toward the tangled growth in the back yard of adjoining private properties along Englewood place. Flight was not attempted nor did the bird give vent to any audible cry of alarm. The speed with which the pheasant ran indicated that the bird was in no way physically handicapped and that it was alert.

Probably this pheasant had wandered into the park late the preceding evening or earlier the same morning from the more sparsely populated section of the city beyond New Scotland avenue, one-half to three-fourths of a mile south of Washington Park. Extensive grassy fields and fence rows, sparse woodlands and unkempt weedy tracts occur in that territory and offer food and cover for these hardy birds. On May 12 and 14, 1941, and April 30, 1942, while in the park, we heard the typical harsh *"kock-kock"* of a male evidently from this cover; residents of that section report frequently seeing and hearing the birds.

The ring-necked pheasant, really the common pheasant as the species now are mixed, was first successfully introduced into the United States in 1881, with the shipment of 28 birds from China to Oregon. Six years later it was introduced into eastern United States. Since that time, with augmentation and maintenance of its numbers through liberation from state game farms as well as from private agencies, this stately bird has continued to occupy a prominent place in the ornithology of almost every northerly state in the East. Since 1909, when it first began the work, New York State has been one of the leaders in rearing pheasants for stocking purposes. So successful have been the combined effects of restocking and restrictive hunting legislation that this game bird is now well established in most of the agricultural counties of the State. The hunter kill of 263,000 males in 1935, as reported to the Conservation Department, attests to the popularity of this pheasant as a game bird. For 1925, the reported kill was 156,362 birds.

Seldom can one drive through the capital district countryside without hearing or seeing this species. Not infrequently the birds, especially the females and young, are killed in attempting to fly or run across the highway too close to a rapidly approaching automobile.

As with other representatives of this family during the mating season, the cock often engages in such antics as crowing, strutting and wing flapping in an effort to gain the admiration of and acceptance by the female. Nests with eggs may be found from late April through July. Open, brushy pastures, sparse woodlands, or marshy hay or grain fields are favorite nesting sites. Leaves, grass and straw comprise the usual nest materials and from six to 12 olive-brown eggs make up the average clutch. The extremely precocial young accompany the female for some days or even weeks following hatching. Their protective coloration renders them inconspicuous and this feature is made more effective through the "freezing" attitude which is assumed when danger threatens.

A large amount of vegetable matter enters into the diet of the pheasant. Buds, stems, shoots and leaves of various wild and cultivated plants are eaten, while weed seeds and the fruits of wild grape, choke cherry, elder and hawthorn together with a certain amount of cultivated grain comprise a considerable proportion. Larger insects such as grasshoppers, crickets, beetles and moths are also freely taken. Without doubt, the frequent complaints of farmers and horticulturists concerning injury to garden truck such as corn, potatoes and tomatoes, are well-founded and the birds' economic status depends much upon the prevailing local conditions. In evaluating this hardy, introduced form, however, we should consider its importance from the esthetic standpoint as well as its value as a game bird.

ORDER GRUIFORMES

Rails, Coots, Gallinules Etc.: Family Rallidae

Northern Virginia Rail* *Rallus limicola limicola* Vieillot

Length 9.5 inches. Upper parts olivaceous, dark streaked; wing coverts rufous; cheeks gray; bill decurved, bright red with dusky base and tip; iris red; throat white; remainder of underparts brownish, flanks blackish and white barred.

Despite the fact that this retiring and rather uncommon local summer resident is an inhabitant of swamps and marshes of which there are none in Washington Park, a single individual found moribund within a few feet of the west border of the park provides some justification for inclusion of the species in this report.

On the afternoon of May 10, 1940, a badly injured but still living Virginia rail was discovered lying on the street paving of South Lake avenue, near the southwest corner of Washington Park by Mrs J. A. Stromberg of Albany. The tail-feathers were missing and bruises on one side of the body indicated that the bird had struck a wire or other object in flight, and injured itself so badly that it died a short time later while held in Mr Stromberg's hand. The rail must have flown over or at least within a few feet of the park, so it is included in the park list. Upon dissection it was found to be a male. The specimen has been preserved as a study skin in the Zoological Collections of the New York State Museum, Accession No. 6133.

Despite the fact that the Virginia rail and its allies possess a weak and vacillating flight, they perform long migratory journeys, usually at night. During these migrations the birds often fly into wires just as did the Washington Park individual; the mortality from this cause is considerable.

In the Albany region the Virginia rail usually appears in spring about mid-April; few are seen by the close of September. During the summer the bird nests and feeds in marshy pools where cattails, swamp loosestrife and allied vegetation grow. Sometimes a considerable number may inhabit a rather circumscribed bit of suitable marshland. It is a wary bird and will not knowingly expose itself long to view; but if the observer will remain quiet and motionless for a time he may experience the thrill of observing this rail at close quarters. When startled the bird seeks safety by running rather than flying. Its ability to dart through openings among the rushes and to run over partly submerged vegetation is extraordinary. The Virginia rail also is a good swimmer and diver and if too closely pursued will often hide near a tussock of plant growth with only its bill projecting above the water. It is most active physically and assiduous vocally as evening comes on.

The voice is a coarse *"ka-ka"* and both adults and young give vent to a kind of squealing note not unlike that of a pig. An evening visit in late summer to a marsh well-populated with adult and young Virginia rails will usually provide the observer with an abundance of aural evidence on this point.

The few briefly indicated characteristics here mentioned serve to show that the Virginia rail rarely occurs in Washington Park.

ORDER CHARADRIIFORMES

Plovers, Turnstones and Surf-Birds: Family Charadriidae

Northern Killdeer* *Charadrius vociferus vociferus* Linnaeus

Length about 10 inches. The grayish brown upper parts, bright rufous rump, white underparts with two black bands across the upper breast and the characteristic call note, *"killdee, killdee,"* leave no room for doubt as to the identity of this vigorous summer resident of our beaches and open fields.

Although this plover doubtless flies over the park frequently, we have only six positive identifications. On the occasion of our first record, May 16, 1937, the bird flew low over the tree tops in a northwesterly direction, vociferously uttering its characteristic call. About three weeks later, June 6th, a solitary individual was seen and heard flying over. Our only records for the actual occurrence of the killdeer in the park are for May 6 and 8, 1940. On each occasion a single bird was noted on the muddy floor of the drained lake. Ordinarily this plover inhabits not only open sandy beaches and mud flats but also meadows, pastures and cultivated fields. The wooded confines of the park and, under ordinary conditions, the well-circumscribed lake with its limited beach exposure, do not offer much attraction for this energetic and noisy plover. The occasion of our two records for it within the park boundaries under the circumstances mentioned, however, provides a good illustration of the way in which even only temporarily modified ecological conditions may affect the status of a species within a very limited area. Under conditions likely to prevail in the park, this bird will probably occur there only accidentally or casually. Our first and earliest seasonal record was for one individual flying low and in a northwesterly direction over the park on April 11, 1941. The bird called a couple of times as it flew low enough for us to make out the black collar. One was again distinctly heard as it flew over on April 28, 1941.

The killdeer can run rapidly and exhibits the usual ploverlike characteristics when feeding; running for a short distance, then suddenly stopping with head erect or perhaps pecking at something on the ground; then it runs on again and repeats the performance. Like most other shore birds it has a habit of nervously bobbing the head and teetering the body, particularly when it is alarmed. Often, especially in spring, the males perform various types of strutting and plumage display, accompanying them with loud, and sometimes pleasing, vocalization. As a part of these demonstrations, the tail is frequently spread so that the black and white band at the tip is evident and the bright rufous rump and upper tail coverts are also prominently displayed.

Woodcock, Snipe, Sandpipers Etc.: Family Scolopacidae

Spotted Sandpiper* *Actitis macularia* (Linnaeus)

Length 7.5 inches. Adults in spring and summer have the upper parts brownish gray with a greenish sheen, marked by transverse black bars; underparts white, marked on breast and sides with conspicuous roundish black spots. When the wing is extended in flight a long, transverse white bar is exposed. Bill short, straight; legs greenish yellow. Young and adults in winter, white below, breast ashy. The "teetering" habit so characteristic of sandpipers and their allies is more persistently indulged in by this bird than by any other.

Although our earliest spring record for the "teeter-tail" or "tip-up" in the park is April 26, 1938, it is seldom seen there before the first week in May. From about May 10th to the close of the month, one or two individuals are likely to be noted each morning along the shore of the lake. Our latest date for its occurrence there is June 14, 1940. In that year it was noted also on seven of the ten early morning trips taken between May 11th and June 14th. It has been seen at the margin of the lake in nine of the ten years of this study.

We have never observed more than two individuals at one time. Usually the bird calls attention to itself, as it feeds on the beach debris, by its alternate running, bowing and bobbing with occasional utterance of its sharp *"peet-weet"*. Sometimes red-wings and bronzed grackles join in the hunt for food in the same situations. And often the sandpiper appears to arouse the ire of the grackles, which pursue them relentlessly both on the shore and in the air as the sandpipers fly back and forth along the length of the lake.

This is the only one of the small sandpipers that breeds in the Albany region and from about June 1st on through the summer, the spotted sandpiper is not found often in the park.

During the 1946 spring season, however, the junior author had circumstantial evidence of its nesting in Washington Park. One adult was first heard and seen on the lake edge on May 16th. Then on May 19th, a solitary bird was first noticed resting on the grass off a footpath, on top of a small knoll on the south side of lake and about 70 feet distant from the water. It was so quiet that the first thought was that it might be wounded. On being approached, however, it ran in characteristic, bobbing fashion off into the grass. The next morning it was flushed again and like a nesting bird uttered no calls. In the afternoon of the same day, while the author was with Doctor House, the State Botanist, listing trees and shrubs in the same locality, the bird again ran out, sneaking off in the tall grass; we both remarked that its behavior was like that of a bird flushed from a nest. Then on an early morning trip on June 6th, a spotted sandpiper was seen to fly from the same hillside to the edge of the water where it began to look around quietly but busily and hurriedly as if in search of food. Up to this time the weather had been fairly cool, so that not many people were in the park to disturb birds. Although search was made for the nest and bird some days later, neither was found and there is thus only circumstantial evidence of its nesting here.

Authorities give 14 to 16 days as the incubation time for this species and state that the young are able to run soon after hatching. Eaton (1910) says the bird nests along every stream, pond and lake in the State and that the eggs are deposited between May 15th and June 20th. Spotted sandpipers are known sometimes to nest in fields quite a distance from water, so this hillside location could well have been a nesting site for the individual bird mentioned.

Eastern Solitary Sandpiper* *Tringa solitaria solitaria* Wilson

Length 8.5 inches. Dark grayish above with a greenish cast, more or less variegated with white; head, neck and breast white-spotted and streaked with blackish; a conspicuous white area around the eye; rump blackish, the outer tail coverts spotted or barred; tail white, black-barred.

In our experience the solitary sandpiper was more than usually common in the spring of 1940 in the Albany region where, ordinarily, it may be indicated as a fairly prevalent transient. Possibly its inordinate numbers, the extensive beach expanse of the partly drained lake and the narrow drainage ditch extending lengthwise of the depression forming the lake proper, may have accounted for the presence of two individuals there on the morning of May 19th. This is our only park record.

Also in the spring of 1940, we often saw this sandpiper in and along ponds and streams near the outskirts of Albany. From our observations, however, we believe that its occurrence on such a body of water as the park lake in the heart of the city is only casual or accidental.

The solitary sandpiper or "woodland tattler," as it is sometimes called, is distinguished from the spotted sandpiper by its slightly larger size, particularly its longer neck, its longer and more slender black bill, conspicuously barred outer tail feathers, lack of white bar on the wing and black legs. The characteristic nervous movements so prevalent among the sandpipers are in this species confined to a nodding of the head rather than teetering of the body.

This is a quiet, unsuspicious sandpiper, partial to woodlands that border fresh-water ponds, lakes and streams. Often it will permit the observer to approach very closely before taking wing. Its flight is light and graceful and on alighting, it elevates the wings high over the body, displaying in that act the conspicuous, regularly barred wing linings and axillars. Despite its common name the bird is not always solitary in habits. Although we have often seen only one or two together at the height of the migratory movements, we have just as often noted five or six or more in a loose group.

Semipalmated Sandpiper* *Ereunetes pusillus* (Linnaeus)

Length 6.5 inches. The smallest sandpiper recorded for the park. Its comparatively short, stout bill, distinctly grayish upper parts and blackish legs are good field characters. The semipalmated or partially webbed condition of the front toes can be noted on a specimen in hand.

This little sandpiper is typically a gregarious beach bird, a transient in the Albany area where it is much commoner in autumn than in spring. So, quite unexpectedly, but with a great deal of satisfaction, we discovered on the morning of May 18, 1940, a single example on the north bank of the partly drained lake just east of the bridge. It was probably a straggler, for most of its kind move north through this territory by mid-May. We watched the bird through the binoculars for several minutes during a part of which time it was not more than 30 feet distant.

The date of this observation followed, by some two weeks, the drainage of the park lake for the purpose of cleaning it and of removing the plant growth. By May 18th the work had been completed and the lake was partly filled with water but a considerable expanse of sandy beach was still exposed. And, while it had been rather copiously strewn with quicklime in an effort to deter plant growth, the lime seemed in no wise to act as a deterrent to this bird although it appeared to have a slight effect upon grackles and possibly other birds. As a matter of fact, this considerable beach expanse accentuated by the white lime may have been responsible for attracting the bird to the park. In any event this was and still remains our only park record for the semipalmated sandpiper. And, as far as we can determine, the species had not been identified therein by earlier workers. In 1940, however, this species seemed to be commoner than usual in the Albany territory.

Gulls and Terns: Family Laridae

American Herring Gull* *Larus argentatus smithsonianus* Coues

Length 24 inches. Our largest "sea gull." Adults in summer with back and wings pearl-gray; primaries mostly black, tipped with white; rest of plumage white; bill large, yellow with a red spot near tip of lower mandible; feet yellowish or pinkish. Two to three years are required to attain fully mature plumage. Immature birds are grayish brown above and below; tail and primaries brownish black; bill and feet flesh-colored.

Washington Park and its environs do not furnish the type of habitat that appeals to the herring gull and we have never seen the bird within the park boundaries. In the Albany region, however, this gull is a common transient and occasionally winters here or at least not far to the south where it can find open water; and summer stragglers also sometimes occur. The principal local flyway and gathering place is, of course, the Hudson river one and one-half miles east of the park. Sometimes the birds take a short cut across country to some point several miles or more northwest of Albany on the Mohawk river between Troy and Schenectady or beyond. It is on such local movements that a view of the herring gull is likely to be had from the park. No doubt we have missed many of these flights, for over the period encompassed in this report we have but a dozen records, between the early date March 27, 1936, and the late date, July 1, 1942, during 1935 to 1944 inclusive. We have no records for this gull over the park in

1940, 1941 and 1943. A single bird was observed on most occasions; the lone individual seen on May 18, 1938, flew so low that the immature plumage was plainly visible. But on April 16, 1944, however, 11 individuals were counted flying low and southwest over the park.

Ring-billed Gull *Larus delawarensis* Ord.

Length 18.5 inches. Adults in summer are much like the herring gull but smaller in size; bill with a black ring or crossbar near the tip. Immature birds are similar to those of the herring gull but have a white tail with a narrow, black band near the tip.

Although this gull is a fairly common transient visitor in the Albany region and within the past few years appears to have shown a marked increase in numbers and prevalence, it was not seen in the park. And on only a few occasions between March 25th and May 13th, have we observed it flying over at a sufficiently low altitude for positive identification. On the occasion of our first record, May 13, 1938, four individuals flew along together in a loose group at a low altitude and in a northwesterly direction. Within a few minutes a fifth bird followed. Evidently the gulls were moving from some point in the Hudson river near Albany to the Mohawk somewhere in the vicinity of Schenectady. Only single individuals were noted on each of these occasions, namely, April 2 and May 5, 1939, and April 27, 1940. The only other time we noticed the species over the park was in the early morning of March 25, 1943, when five birds were seen flying over the north side in a westerly direction; they were in a loose group perhaps 250 feet above us. It seems that we should see this bird oftener than our records indicate.

The eastern breeding grounds of the ring-billed gull are in southeastern Quebec and Labrador and usually by June, the local population, save possibly a few stragglers, has moved out of our territory not to reappear in numbers until late September or early October.

This gull is sociable and gregarious, associating not only with its own kind but with the herring gull and others as well. Usually any local group of gulls whether observed in spring or autumn on the water or in winter on an ice floe will comprise both of the named species. Often these groups comprise not only adult but immature birds of different ages representing a variety of intergradations of plumage; as a result, the observer may have some difficulty in making identifications. The smaller size of this bird helps in differentiating it from the herring gull, especially when they are seen together.

The ring-bill is more agile on the wing than the herring gull. Both are good swimmers, riding the water gracefully and buoyantly. As with most other gulls also, both species are general feeders living on fish and other forms inhabiting water. They are scavengers, too, always on the alert for floating refuse on beaches, about harbors and lake shores and in the wake of vessels.

ORDER COLUMBIFORMES

Pigeons and Doves: Family Columbidae

Rock Dove* *Columba livia* Gmelin

Length 13 inches. Above slate gray, head and neck darker, the latter with greenish reflections; back and wings paler, rump white; breast dark slate, the belly light slate; tip of tail with a broad black terminal band. Birds of domesticated origin add numerous variations in color.

Like the starling and English sparrow, the domestic pigeon or rock dove has now been introduced into this country for so long a time that it constitutes a part of the avifauna of almost every locality both urban and rural. The foundation stock has been domesticated birds of man-made varieties of the rock or blue rock pigeon, an inhabitant of southern Europe and northwestern Africa. Lacking artificial selection, the birds comprising the loose flocks so characteristic of our city streets exhibit a tendency to revert to the coloration and appearance of the type from which they sprang.

Because of the sympathetic and tolerant attitude of many well-intentioned people exhibited in proffering food, and the availability of shelter and breeding places in towers, on cornices and the like, the domestic pigeon in Albany, as in many other cities, is apparently assured of a comparatively easy livelihood. Too often this encouragement becomes so complete that the birds increase in number to a point where they become a nuisance. Under such circumstances methods for their control can well be adopted. A four-page mimeographed leaflet entitled Suggestions for the Control of Vagrant Pigeons (Wildlife Leaflet BS-143) is available for free distribution by the United States Department of the Interior, Washington, D. C.

The pigeon population of Albany appears to be made up of several more or less distinct flocks, each of which frequents a fairly well circumscribed territory. One of these groups inhabits Washington Park. The flock there usually comprises 20 to 30 individuals, but the numbers fluctuate somewhat in consequence of automobile casualties, attacks by dogs and other exigencies. Winter and summer the birds are fed by visitors and by many local residents in the vicinity of the park. The pigeons find breeding places about the lake house and refectory and in the tower of the church at Willett and State streets. As long as their feeding is a pleasant pastime for so many park visitors a small flock there perhaps can well be encouraged. Their confiding nature, their habit of gathering in a group to receive food and their antics in obtaining it, their aerial sorties both singly and en masse, all provide a certain type of entertainment and emotional satisfaction that is worthy of consideration.

Eastern Mourning Dove

Zenaidura macroura carolinensis (Linnaeus)

Length 12 inches. Above grayish brown tinged with olive, the crown slate gray; below fawn color to pinkish, lighter on belly; tail and wings long and pointed. A bluish black spot behind and a little below the eye; sides of neck with metallic reflections. Readily distinguished from the domestic pigeon by its smaller size, more trim appearance and pointed tail.

The mourning dove, sometimes called "turtle dove" or "Carolina dove," is a common summer resident in the Albany region, the earliest spring arrivals appearing about mid-March; by mid-October most have departed for more southerly climes though occasionally stragglers are found throughout the winter.

Although this dove usually nests in trees it prefers the country for both a nesting and foraging ground; therefore, one would scarcely expect to find it commonly within the confines of a small wooded city area such as Washington Park. As a matter of fact, we identified it on only 16 early morning field trips up to 1946; on five of these, the birds were flying just above the tops of the trees and were not seen to alight in the park; birds perched in tall trees in the park were observed on five separate occasions, three of them in 1940. On one of these dates, May 13, 1940, two doves flew over without stopping, while a third individual perched in a tall cottonwood near the north side of the park. The other listings were for birds identified by the characteristic calls. We have never noted more than three individuals on any one trip. All 16 records of 1933-45 were encompassed by a period of five weeks, April 8th to May 14th. In 1946, the mourning dove was noted on 14 days between April 22d and May 26th; the junior author observed most of these records of a pair of birds that nested in a hemlock tree in front of a residence adjoining the edge of the park on Thurlow terrace. The two adult doves were first seen picking up nesting material on April 23d, and the nest with an incubating adult on it was found on April 30th. Twenty-six days later a parent was observed busily feeding two large young out of the nest. This was positive proof of successful nesting of this subspecies at the park border.

This dove is attracted to, rather than repelled by, the activities and habitations of man for it is possessed of an unsuspicious and adaptive nature. To most of us, the plaintive mating song of the male bird is one of the welcome accompaniments of spring. This mournful cooing note can not be mistaken for that of any other bird and is responsible for the common name of the species. On only a very few occasions did we hear these notes in Washington Park. The nest, a frail platform of sticks, is usually placed on one of the lower branches of a tree. This loosely connected nest at the park border mentioned in the previous paragraph, was located near the end of a branch, seven feet from the ground. Normally two young birds remain in their abode for from 12 to 15 days, during which time the adults feed them by the process of regurgitation. In this procedure the "pigeon milk," a whitish fluid secreted by certain temporarily modified cells lining the crop is ejected with some force into the throats of the highly altricial offspring. Two or three broods may be reared in a season.

The mourning dove which is highly terrestrial, commonly feeds in grain or grass fields or along highways. In food habits it is mainly vegetarian. Stomach examinations made in the laboratories of the former U. S. Biological Survey revealed that approximately 35 per cent of the vegetable substance consists of various kinds of cultivated grain. Most of this is waste, left lying in the field in the process of harvest and would be lost for domestic stock; all but a very small portion of the remaining food items is composed of seeds of noxious weeds.

The flight of the mourning dove is swift and direct. When getting under way the rapidly flapping wings appear to strike each other above the back making a sharp "clapping" sound. Once under way, the sharply pointed wings produce a distinct whistling.

Although open season for hunting the mourning dove prevails in many of our southern states, the bird lacks most of the characteristics that are desirable in the eyes of a true sportsman; for usually it is easily approached and easily hit. Moreover, its capacity for maintaining its kind is limited and a species that has proved itself so valuable an ally of man should receive better treatment from him than it receives when used as a game bird.

FIGURE 15 Tall poplars and a stately residence near the lake. Many warblers find safe resting places in the tops of these hillside trees. April 23, 1938

FIGURE 16 One of the principal attractions for birds in the park is the centrally located six-acre shallow lake. The building to the right is the lake house. April 16, 1938

FIGURE 17 The arched bridge spanning the lake at its narrowest point affords a vantage point for the observer. April 16, 1938

ORDER CUCULIFORMES

Cuckoos and Allies: Family Cuculidae

Eastern Yellow-billed Cuckoo

Coccyzus americanus americanus (Linnaeus)

Length 12 inches. Upper parts soft grayish brown; underparts white; wing feathers largely rufous, the outer tail feathers black conspicuously tipped with white; lower mandible yellow except at tip. The rufous in the wing, large white spots on the tail feathers and yellow lower mandible are distinctive.

This shy and locally uncommon summer resident usually arrives from the South about mid-May and departs about mid-September. Strangely enough all our park records are for the season of 1939, when it was observed six times between May 11th—31st inclusive. Because of its retiring ways, trim appearance, soft wood-brown colors and its tendency to remain high up in the trees, the bird is difficult of detection and it may have escaped our notice on some occasions.

Our first park record was obtained on May 11, 1939, when the peculiar gutteral *"kuk-kuk, kuk-kuk, kuk-kuk, kyow, kyow"* drew attention to two birds in the tall maples bordering State street. The yellow lower mandible and large white spots on the tail-feathers were plainly seen. As we watched the birds, we saw the male copulate with the female, the act occupying a little more than a minute during which sex union was continuous, not intermittent as in many birds. The male held himself in place on the female by seizing her bill in his own, thus bending her neck somewhat back over the body. Evidently one or both of these individuals remained in the park for several days but we have no evidence that they nested there.

It seems strange that this soft-plumaged, stealthy bird should have been missing from our morning trip lists for so long a time, then suddenly have been included on six of them in a single season and not have been recorded during the succeeding season. This circumstance represents one of the unaccountable vagaries of occurrence not infrequently noted among locally uncommon species of birds. It is one of the reasons why the field worker should be constantly on the alert for novelties.

Owing to the popular belief that vocalization by this cuckoo as well as by its black-billed relative presages rain, both have received the appellation "rain crow." Both species of cuckoo share in the habit of retiring unobtrusiveness, particularly during the breeding season when they are partial to untrimmed lowland thickets. Owing to the lack of such growth in the park neither of the cuckoos is likely to be more than a casual transient there.

The nest usually consists of sparsely arranged sticks, lined with dry leaves, grasses and the like and placed in a shrubby tangle, or bush, or small tree at a height of from two to ten feet above the ground. An interval of two to three days is likely to intervene between deposition of each of the three to seven bluish green eggs.

Both the yellow-billed and the black-billed cuckoos are almost entirely insectivorous. Their principal claim to favorable consideration from an economic standpoint is the large number of spiny and hairy caterpillars that they destroy. The forester and the horticulturist are the special beneficiaries of these graceful woodland birds.

Black-billed Cuckoo *Coccyzus erythropthalmus* (Wilson)

Length about 12 inches. Soft, plain grayish brown above and white below; bill including lower mandible blackish; tail feathers blackish, narrowly tipped with white.

Although more common locally than the yellow-billed cuckoo, the black-bill possesses essentially the same traits and characteristics as its near relative. The black bill, absence of rufous in the wing and the small amount of white in the tail, are good field characters.

With the arrival of the cuckoos we can be sure that summer is upon us for they seldom appear in this territory before May 15th. Indeed our earliest seasonal record for the black-billed cuckoo in Washington Park is May 15, 1940. Either this or another individual was seen there on May 16th, 19th and 30th of that year. Again one bird was noted by the junior author on May 15th, 20th, 22d and 23d in 1945. Our only other park records for the bird are May 31 and June 3, 1938.

Both species of cuckoo possess the habit, extremely provoking to the observer who would see their field marks, of keeping their back toward him and of intermittently turning the head cautiously while holding the body motionless though more or less poised for flight. At the same time the birds usually remain partly concealed in the foliage of trees or bushes so that a period of watchful waiting is usually necessary before one can be certain of the identification.

During migration the black-billed cuckoo may visit a variety of locations, even wooded areas such as Washington Park in the midst of a busy city like Albany, but the clang of street cars and the associated din of city traffic are scarcely in keeping with the furtive general habits of the bird. It soon repairs to bush-grown back roads, scrubby thickets, sometimes swampy, or to woodlands or orchards in quiet, sparsely settled districts.

The vocal characteristics of the black-billed cuckoo are somewhat similar to those of its yellow-billed congener, although its voice is softer and the syllables terminating the series of notes run together a little more than those of the yellow-bill. The notes are *"cu cu cu"* or *"kuk kuk kuk,"* but lack the oft-repeated *"kyow, kyow"* ending of the yellow-bill.

In common with its near relative, the black-bill possesses desirable economic and esthetic characteristics. Their destruction of noxious insects, particularly tent caterpillars, webworms and other spring larvae shunned by many birds, are valuable traits which render well-advised the federal and state protection accorded them.

ORDER STRIGIFORMES

Owls: Family Tytonidae

North American Barn Owl* *Tyto alba pratincola* (Bonaparte)

Length 18 inches. Upper parts mixed gray and yellowish buff, mottled or vermiculated with dusky and dotted with white; underparts varying from white to yellowish buff, usually with many small round black spots; facial disk triangular, white, narrowly margined with reddish brown. The large tuftless head, long legs, general light or yellowish coloration, and white face, are good distinguishing characters.

Although the barn owl now commonly nests about human habitations, it occurs as a rather uncommon resident in the Albany region and the senior author says he was somewhat surprised to be able to record it among the birds of Washington Park. His first view of this owl was had about 7.30 o'clock on the evening of August 13, 1936. While sitting on the roof of a State Street apartment building in an effort to gain a little respite from the heat of a sultry day, he noted the unmistakable form of one of these owls in characteristic "billowy" flight not more than 20 feet above the ground, making its way across the northeast corner of the park to the tower of the First Presbyterian Church. Earlier in the summer, about July 10th, the caretaker of that building had reported the presence of owls in the belfry. It appears that in all probability the birds nested here and that the individual observed on August 13th was returning from a foray for food. If sharp nocturnal or crepuscular vigils had been maintained, many other 1936 park records for the barn owl, probably individuals of the same pair or their offspring, could have been obtained.

Further circumstantial evidence of the breeding of the barn owl in the vicinity of the State Capitol within five blocks of Washington Park, came to hand on July 22, 1940, when an adult female in a much emaciated condition was captured in the inner court at the Capitol. It was turned over to the local Humane Association, but despite their ministrations, the owl died and its body was presented to the State Museum. The bird is now in the State Museum Zoological collections in the form of a study skin, Accession No. 6152. Measurements of the bird which was in molt are as follows: total length, 15 inches; wing, 13 inches; tail, 5.8 inches; tarsus, 2.6 inches.

On October 15, 1941, the Knickerbocker News of Albany, New York, pictured a trapped barn owl that had caused a commotion early in the day by its noises and flight on the fourth floor of a large garage one block from Washington Park. The employes who had captured the live bird were advised by conservation officials to liberate it in the country as it was illegal to retain it.

Strictly speaking, the barn owl is not a migratory bird but it often indulges in prebreeding and postbreeding wanderings which carry it north and south, respectively, of its ordinary summer home. This owl frequents almost any type of territory where it can obtain a supply of its favorite food, principally mice and rats; small mammals and an occasional bird make up its chief fare. The name barn owl refers to its propensity for hiding and nesting in barn lofts although it also nests in hollow trees, towers and church steeples; for years one of the towers of Smithsonian Institution in Washington, D. C., has been known to be a nesting site of this species. In common with other owls it is mainly nocturnal in its habits. And, perhaps more than any other, it has been maligned and feared by man. Perhaps its "monkey-faced" appearance, its weird, rasping notes and its inclination to frequent old and little-used buildings have contributed to its undeserved infamy. It is a valuable rodent destroyer that deserves a better fate than usually falls to its lot.

Horned Owls, Hoot Owls Etc.: Family Strigidae

Eastern Screech Owl* *Otus asio naevius* (Gmelin)

Length about 10 inches. The small size, large head, prominent eyes and conspicuous ear tufts or "horns" (length, about one inch) are distinctive field characters. Many amateur observers are unaware of the two color phases of the screech owl. In the gray phase the upper parts are brownish gray, finely streaked with black and mottled with buff; below grayish white, with black shaft lines and wavy crossbars; in the red or rufous phase the ground color is bright rufous or rust-red with similar fuscous markings.

This dichromatism is not associated with age, sex or season; indeed, individuals of both color phases may occur in the same brood of young. In our experience the gray phase seems to prevail among the screech owls of New York State. By way of corroborating this observation it may be of interest to remark that of the 17 specimens of this owl in the zoological collections of the New York State Museum, all of which are from Albany and vicinity, 11 are in the gray and five in the red phase.

In common with most wooded areas, urban or rural, Washington Park usually contains a representative of this well-known and popular member of the owl family. It is probably the commonest species of owl in the Albany area where it is a permanent resident. In the park we have heard its tremulous, quavering wail much oftener than we have seen the bird. Although it may freely utter these notes, which are not at all "screeching" in quality, at almost any time of the year, the Washington Park birds have been most voluble in January and February. And, at one time or another, their voices have reached our ears from practically every section of the park and at different hours of the night. Although we have listed this bird over 20 times during nine years of this park study, we have only three actual sight records for it; the first one was on May 8, 1933, when a single individual was noted in the white pines southwest of the lake. Probably the screech owl nests in, or at least near, the park but our information on this point is not conclusive. Our observation of the species on April 14, 22 and 30, and May 5 and 15, 1942, however, and the presence of occasional hollow limbs and tree trunks suitable for homes, constitute circumstantial evidence which should not be overlooked. A late summer record is of interest as indicating a food habit of this species. About dusk of the evening of August 24, 1943, a bird of the gray phase alighted on a dead elm stub above our heads near the Soldiers and Sailors Monument at State street and Northern boulevard. After a few moments, it flew down toward the base of a near-by elm to seize something, perhaps a cicada, from the bark, and then flew away to a tree a few yards east.

Owing principally to its small size and largely nocturnal and crepuscular habits, the screech owl often escapes notice; therefore, the observer should be on the alert for vocal evidence of its occurrence. Usually this owl remains concealed in a hollow tree or in dense evergreen or other growth during the day. Often its presence may be detected by investigating the cause of concerted and persistent outcries of blue jays or crows, which often unite their efforts to harass some luckless individual they have discovered. In daytime, unless disturbed too much, the screech owl usually attempts to ward off enemies, human or other, by a sharp snapping of its mandibles rather than to evade them by taking flight.

The screech owl usually retreats for rest and nesting to hollow trees and deserted woodpecker holes in orchards and wood lots about farm buildings and other habitations of man; and it often responds to the proffer of suitable nest boxes. Mating occurs in early spring and the usually four or five white eggs are laid in April.

The screech owl feeds principally upon large insects such as certain beetles, grasshoppers and moths. Spiders, crayfish, earthworms, frogs, lizards, mice and other small mammals also are eaten; in addition, small native birds and English sparrows comprise a part of this owl's diet, and are fed freely to the young. During most of the year the food habits of the screech owl are scarcely open to criticism and it deserves the protection that is legally accorded it. At least some of the small native birds on which it feeds are beneficial but the English sparrows that fall prey to it can well be spared. In the long run the small birds which the screech owl takes probably affect little, if at all, the status of the species represented by them. And, even a predatory screech owl has his niche to fill in the nature of things.

ORDER CAPRIMULGIFORMES

Goatsuckers: Family Caprimulgidae

Eastern Whip-poor-will *Caprimulgus vociferus vociferus* Wilson

Length 9.75 inches. Mottled brown, black and white above and below; three outer tail feathers of the male, white distally; no white wing patches as in nighthawk; narrow white band on upper breast. The bird is seldom seen but the call is unmistakable.

This uncommon Washington Park visitor was heard on only one date. In the early morning of May 15, 1945, the junior author heard through opened apartment windows the very distinct *"whip-poor-will"* coming from the park across the street. The bird repeated its name about 15 times, then after a very brief pause it again gave it five times and stopped as abruptly as it had begun. This was at 5 a.m. Standard Time, about 15 minutes before the robins began to sing and an hour before daylight. The weather was favorable, it was a still morning with no wind and even no noise from traffic to disturb the quietness, so the vigorous and rapidly repeated notes were plainly heard.

The whip-poor-will may be recorded when only *heard* as the vocal utterance is distinctive and expressive of its name; therefore any one knowing the bird's common name can recognize the call. The accent is on the first and last syllables with a short *"cluck"* or *"chuck"* between the repetitions, which is inaudible unless the listener is near-by. The entire phrase is voiced in a little more than a second. Roberts (Vol. 1, p. 640) reports, "the rate of 48 songs a minute."

Some years ago (1920) the joint authors counted the calls of the whip-poor-will on many nights in northern Michigan. One bird repeated its name for 396 consecutive times with interruptions of two intervals of two seconds each and one of five seconds as it rested at 9 p.m. in a tree close to our tent. Another individual while sitting atop the ridge pole of the tent at 5 a.m. gave 710 consecutive calls broken by only four brief intervals.

According to Eaton (Vol. 2, p. 164—65) the arrival dates from the South of this species are from April 20th to May 10th, and he states further that, "during the migration (it) is frequently heard throughout the State in localities where it is not found as a summer resident." The bird is said to migrate by night only and the call is usually heard during two hours after sunset and the hour before sunrise. An auditor may hear it one-half mile distant. These creatures, which are less than 10 inches in length, appear tireless as they repeat their notes over and over. They are better known by the sound of their voice than by their flight; their movements are quite noiseless. The silent flight, along with a wide gape with its bordering long bristles, aid them well in their nocturnal search for insect food.

This rare Washington Park visitor which so closely resembles in appearance its near relative, the common nighthawk, is a summer resident of Albany county. The whip-poor-will, however, prefers dense wooded areas for its normal habitat.

Eastern Nighthawk* *Chordeiles minor minor* (Forster)

Length 9 inches. Above black, variegated with whitish. Below, except for the white chin, upper breast and throat barred with black and white. The grayish plumage, long, pointed, blackish wings with a conspicuous diagonal white patch, the forked tail and white throat band, are good field characters. Additional diagnostic features are the usually high, erratic flight and the loud, harsh, nasal *"peent."*

Despite the fact that the nighthawk, which is not a hawk at all or even a close relative, occurs almost daily over Washington Park in summer, we have only two records for it in the park. On the occasion of an early morning trip on May 14, 1935, we chanced to see a bird come to rest in characteristic fashion, its body parallel with the long axis of a branch high up in a tall elm. On May 20, 1942, an individual, after circling over the park, alighted in a similar tree north of the lake house. All our other records are for individuals flying over in migration or feeding, or in the performance of aerial acrobatics. Our earliest spring record for the nighthawk is May 5, 1938, when, in the evening about dusk, a single individual was heard uttering its harsh cry as it coursed about over the west end of the park and adjacent buildings of the State College for Teachers. Other first spring dates for different seasons range from May 6th to May 16th. Our latest fall record is September 21, 1937, when three individuals were noted hawking over the park about 7 p.m. In the Albany region the bird often arrives from the South a little earlier in spring and sometimes is recorded a little later in autumn than indicated by our park records.

Although the nighthawk is principally crepuscular and nocturnal in its habits, it also flies and feeds rather freely during the day. Its flight is characterized by a series of slow, deliberate beats of the long, pointed wings, interspersed with rapid, darting movements and momentary soaring. During the mating season, as well as sometimes during the late summer premigratory flocking flights, which occasionally reach considerable numerical proportions, the birds often ascend rapidly to a considerable height, then dive with the wings held in a rigid V-shape. The rush of air through the wings produces a hoarse vibrating sound. During flight the oblique, white band across the primaries appears like a hole in the wing.

The nighthawk occurs in open and wooded country and is both terrestrial and arboreal in its choice of roosting and nesting situations. This species, too, has become adapted to urban conditions and the presence of human habitations, for not only does it often hawk for food in man-made surroundings, but it also often nests on gravel or other flat roofs of high city buildings. This bird, however, constructs no nest; its two eggs usually are laid on the bare ground or on a gravel-covered roof. A favorite nesting site near Washington Park is the roof of one of the buildings of the State Teachers College only a block away. Circumstantial evidence came to hand each summer of the nesting of the species there. For usually near mid-July the pair that had been noticed almost nightly for the preceding month or more was joined by one, sometimes two, individuals, probably young of the year. It is known definitely that the species nested on one of these roofs in 1936 and 1938 (fig. 34).

FIGURE 18 Looking west over frozen lake from arched bridge on a cloudy cold day. April 1, 1939

FIGURE 19 Ice and snow on lake and bank, first bird trip in 1939. Yet sparrow hawk, junco, robin, fox and song sparrows and five other birds were noted on this date. April 1, 1939

FIGURE 20 The arrow points to bronzed grackle in top of larch tree; the bird not especially disturbed by snow-covered ground. April 13, 1940

Further evidence of a nesting in Albany not too distant from Washington Park came to attention on July 6, 1939, when Mr Charles F. Hall of 358 Sherman street, Albany, brought to our office at the State Museum a young nighthawk not yet able to fly. He had captured the bird alive in a driveway at 357 Elk street, about five blocks northeast of the park. It is altogether probable that this individual was reared on some roof in the immediate vicinity. It is now in the zoological collections of the New York State Museum, Accession No. 6102. Following are the measurements: total length, 5.9 inches; length of wing, 4 inches; length of tarsus, 0.5 inch; width of bill at gape, 0.9 inch.

Usually the southerly movement of the nighthawk begins about mid-August and may continue into or through September. The birds often converge toward and move along some river valley such as the Hudson. Groups of a few individuals up to loose scattered flocks of several scores moving in a leisurely manner at a fairly low altitude and feeding as they go sometimes occur. Several times we have noted small numbers of birds in such a movement over Washington Park and other sections of Albany.

The most notable flight of nighthawks viewed over the park occurred on the evening of August 13, 1936. Our attention was first directed to it by the characteristic harsh calls of the birds. On looking skyward we saw a large, loose group of them, perhaps 300 to 400 feet in the air circling about as though feeding but moving in a general southerly direction. We counted 52 individuals but we are sure that we missed a few and that the flock comprised more than 60 birds. Within a few minutes most of them had disappeared to the southward but later some of them returned to hawk above the park. In a short time all but two or three individuals had disappeared. Evidently a large part of the migration of the nighthawk takes place at night while the daylight hours are occupied in resting. During these journeys it wanders from areas near the Arctic Circle to southern South America.

From the economic standpoint this wholly insectivorous bird ranks high. It feeds upon flying insects which are captured mostly in early morning and in the evening. Its special adaptations for this are a capacious stomach and an exceedingly wide gape; the mouth opens well back beneath the ear openings, forming an effective insect trap. In addition the long, powerful wings enable the bird effectively to pursue and capture such elusive, aerial and, to man, annoying and destructive forms, as mosquitoes and many two-winged flies, moths, wood-boring, leaf-feeding and bark beetles, and plant lice, as well as carpenter and other ants.

It is too bad that this unique and wonderfully expert aerial destroyer of noxious insects has often been used as a moving target for gunners. The nighthawk is deserving of a better fate and all the protection accorded it; shooting it is illegal everywhere in the United States and should be severely punished.

ORDER APODIFORMES

Swifts: Family Apodidae

Chimney Swift* *Chaetura pelagica* (Linnaeus)

Length about 5.5 inches. General coloration dark sooty; wings long, narrow and pointed; tail short, square, with the shafts of feathers projecting beyond vanes in the form of sharp spines; flight rapid, wheeling, often accompanied by a sharp chattering note.

The chimney swift, often colloquially though erroneously called "chimney swallow," is a common summer resident of the Albany region. The first spring arrivals usually appear early in April while the last autumnal representatives ordinarily have moved south by October 1st. Only a few stragglers put in their appearance here before about April 20th; our earliest spring date for the park is April 26, 1938, when a single individual was noted circling above the trees. But from May 1st on through the summer the chimney swift is to be seen almost daily from the park limits.

Never have we seen a chimney swift at rest in the park; all our records are for birds on the wing, circling about either high above the tree tops or, at times, just above the lake into which they often dip momentarily as they pursue flying insects or take a sip of water; an example of this activity was observed on May 31, 1939, when two individuals were seen behaving in this manner. The species occurs commonly about the park all summer but we have no concrete evidence that it nests therein. It is altogether probable, however, that the birds observed during June and July may be individuals that had taken up nesting quarters in some of the tall, unused chimneys of dwelling houses or other buildings in the immediate vicinity.

Chimney swifts feed, drink, bathe and mate on the wing. On June 3, 1942, a pair out of several birds seen over the lake were apparently mating while on the wing. Although they may be observed at almost any hour of the day they are more commonly abroad in the morning and evening. Cloudy periods immediately preceding or subsequent to a storm also are favorite times of activity. In flying ability these birds are most adept. The wing beats are very rapid but they alternate the flapping and sailing methods with expertness and apparent lack of fatigue, for they are on the wing, wheeling, gliding and zig-zagging for protracted periods. Swifts are gregarious and frequently groups of some size may be observed indulging in complicated aerial movements without a trace of collision or interference. The loud *"chit-chit"* of the chimney swift is harsh and unmusical; it may be repeated slowly or rapidly. Several birds fly about together sometimes, uttering the notes alternately or synchronously.

As with other bird species in which the wings are extraordinarily well-developed, the feet of the swift are small, weak and not fitted for perching. The long, slender claws, however, are well-adapted for clinging to a vertical surface while the short, spiny tail feathers support the body. This combination of structures enables the bird to cling for long periods of time to the inner surface of a hollow tree or a chimney, or to the side of a building to rest and sleep. Sometimes several hundred individuals may group together in a favorite chimney. Birdbanders have taken advantage of this habit and a number of workers in this field have thus been able to capture large numbers of swifts. The returns obtained from these captures have provided definite information on migration and distribution.

In late May or early June the chimney swift builds a semicircular, bracketlike nest of dead twigs. These are glued to one another and to the support by a sticky secretion, the product of their salivary glands. In earlier times the bird nested in hollow trees and caves but, along with many other species, it has adapted itself to man-made structures. Now tall chimneys of houses and factories and dark closets or attics of abandoned dwellings are favorite nesting sites. From four to six white eggs are laid in the unlined nest.

The food of the chimney swift consists of such insects as two-winged flies, beetles, flying ants, true bugs and small grasshoppers. Spiders also are taken. Most of this food is taken while the bird is on the wing. Often these small arthropods are abroad in greater numbers on warm summer mornings and evenings and on sultry cloudy days. Such periods of activity call to the feast the highly aerial and insectivorous swifts.

Its small size, alertness on the wing and crepuscular habits preclude man as an important enemy of this highly beneficial bird. Probably it has most to fear from the elements such as sudden, severe and prolonged cold snaps which sometimes cause alarming destruction in its ranks.

Hummingbirds: Family Trochilidae

Ruby-throated Hummingbird* *Archilochus colubris* (Linnaeus)

Length 3—3¾ inches; our smallest bird. Above bright metallic green; wings and tail blackish; below dusky; throat in male with a metallic ruby-red throat-patch or gorget; in female, it is whitish. The extremely small size, slender, attenuate bill and the rapid darting, sometimes hovering flight, leave no room for doubt as to the identity of this "glittering fragment of the rainbow."

In the Albany region the ruby-throat is a fairly common summer resident usually arriving about mid-May and leaving by mid-September. Our earliest spring record for Washington Park is May 11, 1935 and all our first spring records are between May 11th and 18th. Ordinarily not more than one or two individuals were noted on any single trip. This bird, however, apparently exhibits marked cyclical periods of abundance and scarcity. The season of 1935 seems to have been one of these periods of abundance for on several of our morning trips in May we noted two or more individuals. On the other hand, in 1934 and 1936, we failed to record the bird in the park. If it is in the vicinity, it is likely to visit the bright, coral-red blossoms of the Japanese quince (*Cydonia japonica*) which usually reaches the height of bloom about mid-May. The fairly close but nonformal planting of these bushes at the north side of the lake just east of the bridge is the favorite haunt of the hummingbird. Our latest spring date for the species in Washington Park is May 31st. We have no direct evidence that it nests within the limits of this area, although it does rear its young in the southerly and westerly outskirts of the city a little more than a mile away.

There are many popular misconceptions concerning this pleasing and smallest member of our bird population. Some of these erroneous notions concern its flight and flying ability. Misinformed or uninformed persons believe that the bird is constantly on the wing save when it is on the nest; hummingbirds, however, perch to rest and preen just as do many other species. The flight is rapid, the wings beating more than 600 times a minute when the bird is in full flight, but the small size of the species gives an exaggerated idea of its real speed which seldom exceeds 45 to 50 miles per hour. That the bird is a flyer of no mean ability is attested further by its proficiency in hovering, and its ability to fly backwards. The name hummingbird is from the dull hum or whir of the wings.

Another erroneous belief denies vocal ability to the ruby-throat. As a matter of fact, it does possess a "song," a low-pitched, twittering series of notes, often uttered while feeding or indulging in mating activities. It can be heard only if the observer is close to the bird.

Still another popular misconception concerning this pugnacious, high-powered little bird, is that its food consists solely of flower nectar. While it does take some nectar in its visits to flowers, its principal subsistence is derived from the minute insects such as four-winged flies (*Hymenoptera*), two-winged flies (*Diptera*), leaf hoppers and plant lice (*Homoptera*) which often occur in the blossoms. The bird feeds also on plant juices and tree sap and the insects attracted thereto, and captures insects on the wing.

The ruby-throat often constructs its lichen-covered nest in the vicinity of, sometimes in close proximity to, human habitations. Old apple orchards are favorite nesting sites. At times it seems that its judgment in placing the nest is lacking in discretion. Again, this display of architectural skill is saddled so effectively in the horizontal crotch of a low limb of a tree that the observer discovers it with difficulty. Incubation of the two white eggs requires a little over two weeks. The blind and naked nestlings each weigh slightly less than one gram at the time of hatching and remain in the nest for three weeks.

The ruby-throat is often confused with the sphinx moth, also an expert in hovering flight. It has not only the distinction of being the bird of smallest size in this district, but of being the only representative in this section of North America, of the hummingbird family, of which there are some 750 species and subspecies mainly in South America.

ORDER CORACIFORMES

Kingfishers: Family Alcedinidae

Eastern Belted Kingfisher* *Megaceryle alcyon alcyon* (Linnaeus)

Length 13 inches. Upper parts bluish gray; there is a prominent white collar and a white dot in front of eye; underparts white with a bluish gray band across the breast; below this in the female is a reddish brown band, which extends more or less down the sides. The large, crested head, with long, pointed, black bill, the irregular flight and the raucous, rattling chatter, serve to identify this hardy bird.

The belted kingfisher, so characteristic of, and always associated with, any well-watered territory in eastern New York, is a common summer resident here, arriving early in March and leaving for the South in late November; a few stragglers sometimes remain until the streams are frozen over, and an occasional individual may be found in the winter.

Although we have noted the belted kingfisher in the park on numerous occasions it does not occur there regularly or commonly. Probably this is because there are comparatively few fish in the lake and the almost constant proximity of considerable numbers of people does not permit the seclusion demanded by the bird. Most of our park records for the kingfisher are in April and early May. Our earliest spring date is April 10, 1937, and the latest May 29th. By the latter date most of the birds in this territory have repaired to some high bank near water, there to excavate a burrow and rear a family of young. Nestings closest to Washington Park occur in the vicinity of Buckingham lake and in sandy cuts not far beyond. Small streams and ponds in those areas provide a more accessible, constant and plentiful food supply than does the park lake though occasionally a bird may stop there to inspect the possibilities.

The belted kingfisher feeds upon a variety of fish such as minnows, chubs, small suckers, perch and trout. Although small forms two or three inches in length usually are taken, fish of larger size not infrequently fall prey to this avian fisher. The senior author once frightened a kingfisher into dropping its prey which proved to be a six-inch brook trout. Aquatic insects, small frogs and crayfish also make up a part of this bird's diet. So, while it can not be denied that the kingfisher takes some game fish, fry or fingerlings, it largely compensates for this by feeding upon insect enemies of fish and upon minnows which are competitors with the game fish for food.

Hawks and crows sometimes attack kingfishers and, in the park as well as other places, we have seen red-winged blackbirds and bronzed grackles harass them without mercy. Kingfishers are not pugnacious birds and they rely upon retreat rather than battle as the better part of valor. Unfortunately, too, they often serve as moving targets for irresponsible gunners. So, despite their retiring ways and usually large families, these unique representatives of our bird population apparently encounter some difficulty in maintaining their numbers. The birds deserve better treatment than they receive from human hands.

FIGURE 21 Snow-covered east-west drive through center of park. Fourteen species noted to this date, yet 87, the highest list for any one year in our studies, was obtained in this year. April 13, 1940

FIGURE 22 Deep snow and no birds seen today about these Japanese quince bushes which are located near arched bridge. Ruby-crowned kinglets and hummingbirds are attracted here when the red flowers appear. April 13, 1940

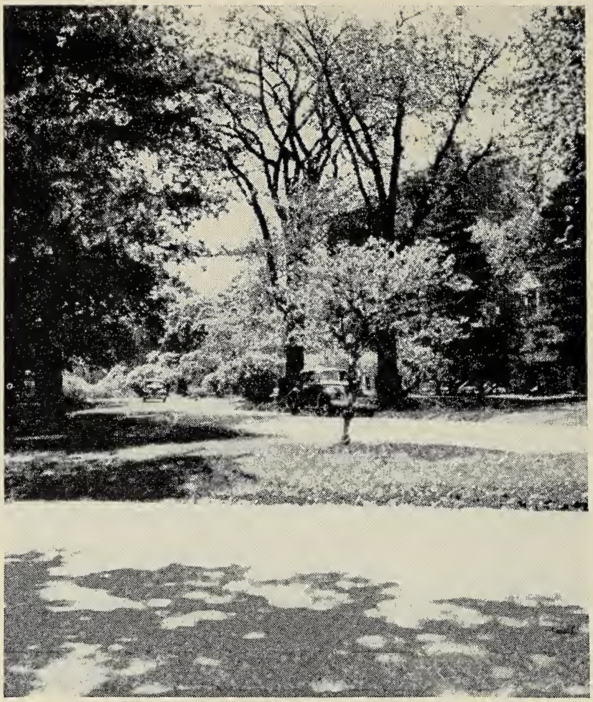

FIGURE 23 Cars in park cause highway mortality of birds. May 14, 1941

FIGURE 24 Lake drained by park officials in order to dispose of pondweed. The exposed lake bed, while less attractive to some species, attracted several other birds. May 7, 1940

ORDER PICIFORMES

Woodpeckers: Family Picidae

Northern Flicker* *Colaptes auratus luteus* Bangs

Length 12 inches. Above brown, barred with black; rump white, occipital crescent scarlet; below grayish white or buffy spotted with black; a black crescent on the breast. Male with a black stripe or "mustache" on each side of throat from base of bill, which is present in young of both sexes until first molt, and which is lacking in the adult female. The undulatory flight, conspicuous white rump and golden-yellow wing linings and lower surface of tail are good field characters.

While an occasional individual of this well-known woodpecker may occur in the Albany region during winter it is essentially a migratory species. Early spring arrivals usually appear late in March or during the first few days of April; few remain by November 1st. Often marked waves or collective movements of these birds are apparent; in both spring and early autumn loose groups of 10 to 20 individuals may sometimes be found.

Although not common in Washington Park, the northern flicker has been observed on almost every early morning field trip. We recorded it on 228 of the 250 formal excursions included in the first ten years of this report. In early spring several individuals, six to eight, are noted on every trip but as the season advances and the birds take up nesting situations in the surrounding territory, only a few pairs remain within the park boundaries. Our earliest spring record is March 22, 1938; all our other first spring dates for the species occur between April 1st and 11th.

The northern flicker is more terrestrial than our other woodpeckers; probably it is seen as often on the park lawn as in the trees. While on the ground it usually busies itself with feeding on its favorite food, ants. It gets these troublesome and abundant insects by inserting its bill into the burrows, enlarging them with rapid up-and-down movements of the head, then extending its protrusible tongue still further into the burrows. The sticky saliva with which its tongue is coated ensnares the ants; the tongue then is withdrawn into the mouth with its load of food.

Although the feet of the flicker are of the typical woodpecker or yoke-toed type, with two toes directed forward and two backward which fit it for clinging to vertical surfaces, the bird often perches on limbs and twigs of trees. Sometimes it rests on a limb with its body parallel to the long axis much after the manner of a whip-poor-will or nighthawk.

Not long after the first well-marked spring movement into Washington Park and the adjacent countryside occurs, the elaborate and interesting courtship of the flicker begins. If the observer remains quiet and at least partially hidden in the park, he may witness the bowing, bobbing, strutting and plumage display as the males vie with one another for the attention of a favored female. On April 14, 1934, we witnessed the mating antics which two males were indulging in while on the ground. On April 16, 1934, we saw a half-dozen individuals performing throughout the park. Added to these displays are the familiar and oft-repeated *"yucker, yucker"* note, the long, rolling *"wick-wick, wick-wick,"* and the drumming on a hollow tree, tin roof or other resonant object.

These courtship activities are continued with more or less ardor all through April but by the first week in May vocalization has diminished and the birds usually have paired. On May 12, 1935, the senior author observed a pair in copula in the park. Although flickers will accept as nesting domiciles boxes and hollow limbs placed for that purpose, such retreats are more likely to be invaded by the plentiful, ubiquitous and belligerent starlings than are the holes made by the woodpeckers themselves. Both sexes take part in excavating the nest hole which may be in a hollow tree trunk or limb three to 40 feet above the ground. During the period of our observations several of the old silver maple trees north of the park lake provided nesting places for these birds. Year after year nests were in the same two or three maples near the west end of the water. Frequently a pile of chips at the base of the tree gave notice of the flicker inhabitants within. A round opening about two and one-half inches in diameter permits access to the nest cavity, which is unlined and may vary in depth from 10 to 24 inches.

The usual complement of eggs is six or seven. The remarkable egg-laying ability of the flicker has been demonstrated on various occasions; the record was that of an individual, which, kept under observation in Massachusetts during systematic robbery of the nest, laid 71 eggs in 73 days.

Despite almost constant harassing and frequent interruptions of their nesting activities by starlings, at least one, sometimes three or more pairs of flickers nest successfully in Washington Park each season. On July 13, 1935, young out of the nest, barely able to fly, were observed feeding on the ground with their parents. And, on July 17, 1939, the members of a family of young not out of the nest long were probing assiduously for subterranean insects in the turf on the north side of the lake.

On May 6, 1941, we noticed a male flicker excavating a hole eight feet up in an elm trunk near the refectory. On the following day the male was still working and the hole was four to five inches deep. Then on May 9th, the cavity was deep enough to conceal the bird which came to the entrance on our approach to the tree. A pair of starlings that had been making life miserable for the flickers pre-empted the excavation, one flying from the entrance on May 12th. Later we found that the starlings successfully reared a family in this nest hole.

On another occasion, namely, May 6, 1944, we watched a female flicker get the better of a gray squirrel which had the fore part of its body in the newly constructed burrow opening; the attack of the mother bird caused the rodent hastily to jump away and disappear.

Young birds reared in the park are sometimes motorcar casualties; on July 14, 1943, an immature was found dead along the highway.

About 50 per cent of the flicker's yearly food consists of ants while the remaining 10 per cent of animal material taken comprises such forms as injurious beetles, bugs, grasshoppers and caterpillars. The fruits and seeds of wild plants make up the bulk of the vegetable diet of the bird although a small amount of cultivated grain and fruit also is taken.

More could be done to encourage the presence of this desirable bird in Washington Park by supplying a greater number of appropriately placed nest boxes in trees and by leaving some of the large decaying limbs and trunks of maples and poplars.

Northern Pileated Woodpecker*

Hylatomus pileatus abieticola Bangs

Length 18 inches; but smaller than a crow. General coloration blackish, adorned with white on the throat, sides of head, neck and wings and with scarlet on the top of the head where the feathers form a crest.

One of the factors that impels the ornithologist to continue his observations over an extended period in a limited area is the hope and anticipation that he may be able to add one more species to his list. The ever-present possibility of such an event lends zest to routine recordings of the usual birds. Picture then, the satisfaction of the senior author when, after six seasons of investigation, including more than 120 regular field trips, he was able to add this largest and perhaps shyest of our woodpeckers to the list of forms actually seen within the park limits.

About 6.30 a.m. on April 24, 1939, while investigating the larches at the west end of the lake he chanced to look skyward when, almost directly overhead and less than 100 feet up, he saw the dark form of a pileated woodpecker. The bird was flying diagonally across the park from west to east in characteristic undulatory, though apparently unhurried, fashion. The observer was able to note the size, the blackish general coloration, with a trace of white in the wings, and the slender outstretched neck. The bird continued flying toward the sun and alighted for perhaps one-half minute in the top of one of the tall poplars just north of the west end of the lake. This fleeting view was sufficient for a satisfactory diagnosis, however, particularly in view of the fact that an individual of this species had been observed, both in flight and at close range, the day previously about eight miles southwest of Albany.

The pileated is shy and ordinarily more or less confined to heavily forested sections. Lately, however, it seems to have been noticed more frequently in the Albany area and perhaps its numbers are increasing. Possibly the individual observed in the park was enroute from the wooded section southwest of Albany to the near-by timbered tracts in Rensselaer county. It is too much to hope, though, that the pileated will be observed more than rarely in the comparatively thickly populated vicinity of Washington Park.

This is the largest species of woodpecker occurring in northern North America. Formerly it was fairly well distributed throughout New York State. It is most commonly found in the coniferous forests of the Adirondacks and Catskills. Perhaps the combination of reforestation, the establishment of extensive preserves in areas not visited frequently by numbers of people and relief from persecution by hunters, will assist in restoring this avian denizen of the woodlands to some semblance of its former prevalence.

Eastern Yellow-bellied Sapsucker*

Sphyrapicus varius varius (Linnaeus)

Length about 8 inches. Back barred with black and yellowish white; wings black with wing coverts forming a longitudinal white patch; tail black, the middle feathers with broken black bars; belly pale yellow; breast black; scarlet forehead; throat scarlet in male, white in female.

The yellow-bellied sapsucker is a fairly common transient in the Albany region. The first spring arrivals appear about April 1st; by mid-October the crest of the local southerly autumnal movement has passed. It is the most highly migratory of any of the woodpeckers occurring in the State. Our earliest spring record for Washington Park is April 4, 1933; the remaining first seasonal records are encompassed by the dates April 8th to 20th. Our latest spring records vary from April 27, 1934 to May 20, 1941. In eastern New York the breeding range of this bird is confined largely to the Adirondacks and Catskills.

In the spring the initial migratory movement includes a preponderance of males. Marked incursions of females occur a little later. Sometimes distinct migratory "waves" of sapsuckers occur. One such was particularly apparent in Washington Park between April 24 and 27, 1939. On April 26th, during a field trip occupying two and three-fourths hours, we noted at least ten individuals indulging in mating antics, similar to, though not so elaborate as, those of the flicker. The tall poplars just northwest of the park lake formed the principal point of concentration. By May 1st the peak of the northerly migration had passed and our May records for the bird in the park were less plentiful than those for April. There was a marked reduction in numbers of this species from spring seasons of 1941 through 1945.

During migration the yellow-bellied sapsucker is comparatively quiet and retiring and may be easily overlooked. It often clings to the side of a pine, maple or poplar tree in the park, busily pecking away without drumming, or furtively eyeing the intruder as it remains partially hidden. Usually if one approaches a tree on which the sapsucker is working the bird will shift quietly to the opposite side and continue round and round the trunk if the observer continues to play the game. At this season, the bird sometimes utters a harsh, squealing *"whee-e-e-e."*

The practice of this bird in drilling through the bark of trees to feed on the exuding sap and to some extent also upon the insects attracted thereto, is well-known. This habit accounts for its common name. Sometimes a considerable area of these squarish, regularly spaced punctures will encircle a tree to effect a damaging drain of sap and so lower vitality that the tree dies. In Washington Park, larches, Austrian pines and maples are the trees most frequently attacked and damaged. Other resinous conifers and hardwoods exhibit scars and sometimes more serious damage. The soft, cambium layer just beneath the bark also is a food of this bird and considerable damage sometimes is done to trees by exposing it. On April 21, 1942, a male was seen working on an Austrian pine east of the lake. The characteristic series of fresh drillings occupied an area six by six inches. These together with old drillings of former seasons have left the trunk of the tree unsightly and probably considerably weakened 10 to 15 feet from the top (figures 42 and 43).

Several times we have found dead yellow-bellied sapsuckers in Washington Park, evidently the victims of boys or men with air guns. One of these birds, a male, found April 26, 1936, weighed 48 grams. Largest diameter of right testis 2.5 mm, of left testis 4.0 mm. Another male, found dead April 30, 1936, weighed 56.4 grams. Both birds are now in the ornithological collections of the New York State Museum, Nos. 5801 and 5802, respectively. Museum specimens Nos. 6193 and 6197 are probably victims of highway mortality as they were found dead on the park road in 1941. The first one, a male, found on April 13th, weighed 44.5 grams; length 8.0 inches; wing 4.8 inches; tail 3.3 inches; and tarsus 0.7 inch. The second, a female, was fat and in good condition and the body was still warm when the bird was found; it weighed 59.1 grams; length 8.2 inches; wing 5.1 inches; and tarsus 0.7 inch.

Eastern Hairy Woodpecker

Dendrocopos villosus villosus (Linnaeus)

Length, about 9.5 inches. Male, above black; middle of back white; white spots on wing feathers; a white stripe above and one below the eye; scarlet patch on back of head; middle tail feathers black, outer ones white; below white. Female, similar but without scarlet crown patch.

This large woodpecker is an uncommon visitor and resident in Washington Park. We were pleasantly surprised to observe a male hairy woodpecker in the tall trees north of the lake near Thurlow terrace on April 4, 1942. This was our first park record; this species, along with the downy, had been reported also during the winter of 1941 at feeding stations only a few blocks away. A male, probably the same one, was again seen in the same location two days later. Hairy woodpeckers were recorded on a total of 17 mornings during 1942, up to June 13th. This subspecies was observed only once in 1943, and four times in 1944. In this latter year a single individual (sex undetermined) was noted in the tall elms near the State Street side of the park, on February 29th and March 10th; while on March 15th a female, and on March 19th, a male were seen. In 1945, this woodpecker was recorded over six widely separated dates when it again nested in the same locality in the park, and in 1946, it was noted on four trips. It is strange that we were not able to find the hairy woodpecker in the park in the late winter or early spring months until the tenth year of our study when it had been reported occasionally in city blocks not far away.

This bird usually nests in rural wooded areas and visits parks or town districts only during the winter months. We found a pair, however, nesting in Washington Park in 1942 and in 1945. On April 29th of the former year, we observed a pair performing various mating antics, similar to those of other woodpeckers. Some time later the nest was located about 15 feet up in a maple stub near the lake house. On tapping this tree at its base with a stick on May 14th, we disturbed the female, evidently incubating. She appeared at the entrance of the nest hole and flew out immediately. Our latest observation date for a female in the park was June 13th.

As our records indicate, the hairy is not seen as commonly as the downy, with which it is often confused. As the markings of these two woodpeckers are similar, an amateur student should learn to differentiate between them by noting that the hairy is about the size of a robin and the downy is noticeably smaller. Then, too, the bill of the larger bird is longer and it is really quite powerful in probing the bark or in cutting out chips; it produces a louder tapping or drumming noise that can be heard some distance away. The call notes of this woodpecker are louder, shorter and not uttered as frequently as those of the downy.

A greater part of the diet of the hairy is of destructive or injurious insects which infest trees. In obtaining its food, it does not damage the bark of trees as severely as does the sapsucker; it is one of our most beneficial birds.

Northern Downy Woodpecker*

Dendrocopos pubescens medianus (Swainson)

Length about 7 inches. Above black with middle of back white; middle tail feathers black, outer ones white barred with black; below white; male with scarlet patch on back of head; female, without it.

This smallest and probably best known of our woodpeckers is less shy than the other local representatives of the family. It is prone to frequent woodlands, orchards and shade trees about rural dwellings and to inhabit, throughout the year, parks and wood lots in and near towns and cities. This subspecies is one of the very few consistently permanent residents of Washington Park. We have observed it there every month in the year although it is commonest in April. One or more individuals have been noted on 174 of our 250 regular spring field excursions in the park.

Although the downy usually rests and feeds while clinging to a vertical surface, it frequently perches crosswise on small twigs or wires like a typical passeriform bird. In common with its near relatives, it has the undulatory type of flight. The usual call of this little woodpecker is a sharp metallic *"peek,"* sometimes repeated rapidly with a gradual diminution in pitch.

Usually the downy woodpecker excavates its nesting quarters in the stub of a dead tree or limb. The hole is about one and one-fourth inches in diameter and leads to a gourd-shaped cavity six to ten inches deep. These unlined nest cavities may be eight to 40 or 50 feet above the ground. Excavations begin in late April or early May and are shared by both sexes.

One or more pairs of downies nest in Washington Park each season. Upright dead elm stubs appear to be most in demand by them. On May 3, 1938, a pair of birds was working on a nest cavity in a dead elm stub about 45 feet above the ground on the south side of the lake. On May 3, 1939, two pairs had excavated nests; one 35 feet up in the dead stub of a maple tree at the north side of the lake just east of the bridge, and another 40 feet high in a maple at the northwest corner of the park near Lake avenue. Similar situations are selected by birds each season. The four to six eggs are white.

Extensive stomach examinations made by the former United States Bureau of Biological Survey showed that more than 75 per cent of the food of the downy woodpecker consists of animal matter, principally ants and the wood-boring larvae of moths and beetles. About 24 per cent of the bird's food is made up of vegetable matter, mostly wild fruits and seeds. The usefulness of this little woodpecker in checking destructive forest, orchard and shade tree insects has long been recognized; this bird merits every encouragement we can give it by providing food in winter, nesting boxes in summer and protection the year around.

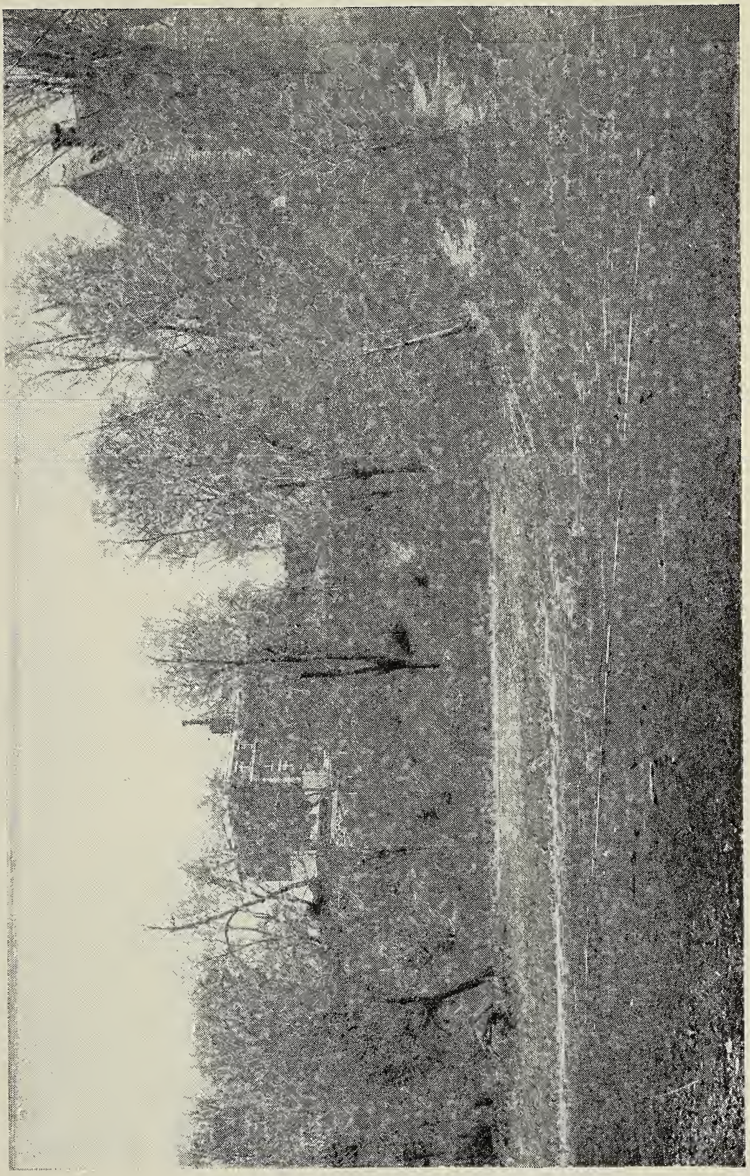

FIGURE 25 Bronzed grackles feeding on drained lake bed. May 7, 1940

FIGURE 26 A group of larches on the south shore of the lake. Goldfinches, brown creepers, kinglets, nuthatches and warblers often congregate in this enticing spot. April 23, 1938

FIGURE 27 Warblers, vireos and flycatchers are attracted by this combination of water and bordering trees. May 31, 1938

ORDER PASSERIFORMES

Flycatchers: Family Tryannidae

Eastern Kingbird* *Tyrannus tyrannus* (Linnaeus)

Length about 8.5 inches. Upper parts slaty-black, crown with a usually concealed, orange-red patch; tail black, tipped with white; underparts white.

This common summer resident in Albany county was seen only once in Washington Park and that was on the morning of May 4, 1942. This was an early record for the region as we usually observed the kingbird out in the country about May 6th or 8th. The individual seen was found in the tall trees at the north edge of the park near Thurlow terrace. It was making aerial sorties for flying insects from the lower branches of trees but uttering no sound. The striking white band across the end of the dark fanlike tail was plainly seen as were the grayish black upper parts and whitish breast.

This handsome bird prefers roadsides, pastures and orchards for its usual habitation rather than city parks. In the country, a pair often selects a solitary pear or apple tree in which to build their nest. They are noisy birds, keeping up a chatter as they carefully guard their territory from the intrusion of others; at times they are aggressive and belligerent and drive away crows or even hawks that come too near their home.

The eastern kingbird does not have a musical song and the high-pitched, harsh notes which it frequently utters can not be mistaken for those of any other bird; it sounds like *"ka-chuck', ka-chuck', ka-chuck',"* rapidly repeated many times.

Popular names for this species are "bee-martin" or "bee-bird," as it is known to kill and eat honeybees. It also consumes a small amount of fruit, but 90 per cent of its food consists of insects which are in the main injurious. Such delicacies as moths, flies, weevils, beetles and grasshoppers make up a large share of the diet of the kingbird and it can be considered a beneficial bird to have about a garden or orchard.

Northern Crested Flycatcher* *Myiarchus crinitus boreus* Bangs

Length 9 inches. Above olive-brown, tinged with greenish; head crested; breast grayish, belly sulphur-yellow; inner webs of all but the central pair of tail-feathers reddish brown. This is the largest of our flycatchers. Its loud, distinctive *"whe-ep,"* sometimes followed by a coarse rolling *"raa, raa, raa,"* usually is uttered from some vantage point such as the top of a tall tree.

This raucous-voiced flycatcher occurs fairly commonly as a summer resident throughout the Albany area. First spring arrivals reach this territory about May 1st; by mid-September few remain. Low-lying, isolated wooded districts adjacent to or near water are the most frequently occupied habitats of the crested flycatcher; and as Washington Park does not have these characteristics, it is likely to attract this species but casually during the spring migration. The tall trees on the park hillside and the central lake, however, do provide features hospitable to an occasional individual during the first days following its arrival from the southland.

On our 250 early morning spring excursions in the park we have recorded the crested flycatcher just eight times, May 7, 9 and 11, 1938, May 18, 1936, May 10, 1939, May 14, 1940 and May 14 and 30, 1942.

The crested flycatcher usually constructs its nest in a hollow tree or limb or in an abandoned woodpecker hole 10 to 20 feet above ground. To the grass, rootlets and hair that comprise the bulk of the nest, the cast skin of a snake is often added. Whether, as some have asserted, this item serves a useful purpose in frightening away marauders is problematical. The ordinary complement of eggs is four.

This bird is almost wholly insectivorous and with the exception of a few predaceous and parasitic four-winged flies (*Hymenoptera*) its principal food items are inimical to man's best interests. This beneficial bird can be encouraged to nest about cottages, camps and homes in the vicinity of woodlands by providing suitable nest boxes.

Eastern Phoebe* *Sayornis phoebe* (Latham)

Length about 7 inches. Above grayish brown, head darker; wing bars inconspicuous; bill entirely black; outer vane of outer tail feathers white; below white, more or less washed with yellowish, and tinged with grayish on the breast and sides. These characters, together with the erect perching posture, the persistent tail wagging, and the emphatic *"phoe-be"* note leave little room for doubt as to the identity of the bird.

This commonest and most domestic of our flycatchers is the earliest spring representative of the family to reach this section, often arriving before mid-March. It usually remains in autumn as long as the weather continues mild enough for the daily flight of insects upon which the phoebe largely depends for food. Although this bird often visits and even nests in close proximity to the habitations of man, the volume of human traffic through Washington Park apparently deters its presence there in any number. Our earliest spring park record is April 4, 1942;

the greatest number of times in any one season that we recorded the species on our regular field trips was six in 1936, in which year also our latest spring sight record, May 18th, was obtained. Never have we noted more than four individuals on any one trip. Not once in the seasons of 1933, 1938 or 1940 did we observe the phoebe in the park.

As suggested by one of its colloquial names, "bridge-bird," the lake bridge is the principal stronghold of this flycatcher in the park. On the few chill April mornings that we have seen it there, it was darting out from the stone abutments of this structure or the adjacent bushes at the water's edge to capture flying insects. Between these aerial sorties it gave voice to the characteristic, rasping, unmusical *"phoe-be"* note, usually accenting the first syllable, to the accompaniment of a wagging or pumping movement of the tail. Following its local prenesting wanderings which sometimes take it to such urban situations as Washington Park, the species takes up nesting territory in suburban and rural sections.

Highway bridges and farm outbuildings, even the frequently used verandas of country homes, are favorite summer haunts of the phoebe. In such surroundings the usual nest of grass and mud, covered on the outside with moss and lined with horsehair, is constructed. A pillar, beam, joist or casement often serves as a supporting structure. Variations in placement and in nest materials occur in response to local conditions. Sometimes an abandoned barn swallow nest is adopted by a pair of phoebes and modified to satisfy their inclinations. Three to six white eggs constitute the usual clutch and often two broods of young are reared in a season.

The food of the phoebe consists almost entirely of insects taken on the wing. Such noxious forms as two-winged flies, including the housefly and mosquitoes, moths, including the adults of cankerworms, woolly bears, codling moths and their larvae, leaf beetles of many kinds, grasshoppers and ants are all part of this bird's diet. In fairness it should be pointed out that some useful parasitic and predaceous insects and honeybees also fall prey to the phoebe but they are in the minority. During early spring and fall when the supply of available insect food is reduced, this flycatcher often consumes wild berries, seeds and other vegetable material.

Its trusting nature, domesticity and insectivorous propensities combine to render the phoebe a desirable bird about our homes. No fear need be felt that the mites with which the young are often so visibly and plenteously afflicted will take up residence in dwelling houses or molest the human occupants.

Yellow-bellied Flycatcher*

Empidonax flaviventris (Baird and Baird)

Length 5.5 inches. Above dark olive-green; wings and tail blackish, the former with white bars and edgings; below decidedly yellowish; an indistinct olive band across the breast; upper mandible black, lower mandible pale.

Of our three small flycatchers yellow-bellied, Acadian and least, which are all very difficult to identify in the field, this is the most easily distinguished by reason of the sulphur-yellow underparts. In the Albany region it is a rather uncommon transient in spring between late May and early June and in late summer, from mid-August to mid-September or a little later. Included in its breeding range is the Canadian Zone of this State while in winter it occurs from Mexico to Panama. Even in migration time such areas as Washington Park offer little inducement to the yellow-bellied flycatcher which, on the basis of our observations, occurs there only sparingly and irregularly.

While we have actually recorded this quiet, retiring little flycatcher in the park (in the spring) only five times, May 18, 1936, May 31, 1937, May 19, 1939 and May 19 and June 7, 1941, it is possible that we may have overlooked it on some occasions. Judd does not list this flycatcher for Washington Park but Caduc records it on the following dates: May 25, 1912; May 19, 1913; May 8, 1914; May 18, 1915; May 18, 1916. We recorded the yellow-bellied along with 12 other species on a two-hour afternoon trip in the park on September 15, 1943, which furnishes an instance of a fall visit to the area.

Like its congeners, in migration, the yellow-bellied flycatcher is partial to the lower, shaded branches of closely growing trees, usually near water; it often perches also on the top of small trees. Erect posture and the habit of darting from its perch and with a snap of its bill capturing a passing insect, then returning to or near its former position, it shares with other small flycatchers.

Acadian Flycatcher* *Empidonax virescens* (Vieillot)

Length 5.75 inches. Above dark olive-green; wings and tail brownish black; two distinct yellowish white wing bars; below whitewashed with greenish yellow; throat white; upper mandible black, lower mandible flesh-color. This is the greenest of all our representatives of the family. In addition to the characters mentioned, the frequently uttered *"peet"* accompanied by a perking of the tail is a helpful field character.

For the Albany region in general and Washington Park in particular, this is another uncommon transient. On only three occasions have we observed the Acadian flycatcher in the park; the first was seen on May 3, 1938, in low bushes on the north side of the lake. Although this is an early date for the bird in this territory, the spring season of 1938 was unique in that it was an early one from the standpoint of vegetational growth and the arrival of many species of migratory birds. We recorded it again May 20, 1940 and May 14, 1941; on the latter date one individual was observed on both morning and afternoon trips in a bushy backyard adjoining the park.

The Acadian, or "green-crested flycatcher," prefers moist, wooded situations, which are not offered in the park so that it could scarcely be expected there except occasionally during migration. It appears to be common nowhere in the State.

Least Flycatcher* *Empidonax minimus* (Baird and Baird)

Length about 5.5 inches. Above olive-brown; wings and tail dark brown; two grayish white wing bars and a white eye ring; below whitish with an indistinct grayish band across breast and a tinge of yellowish on the belly; lower mandible brownish. This is our smallest flycatcher. The short, sharp *"che-bec'"* accompanied sometimes by a slight jerk of the head is a helpful field character. Since the least and Acadian flycatchers have similar plumage, the oft-repeated emphatic call of *che-bec'* is the best identification of this species in the field.

From mid-April to about mid-October this little flycatcher voices its presence in the Albany region from orchard fruit trees as well as from the shade trees of dooryards and roadsides. Next to the wood pewee it is the best represented member of the family in Washington Park. In only one season (1934) have we failed to record it there. On the other hand, in its year (1938) of apparent greatest abundance during our investigations, we noted it on only five of 34 regular morning trips. Our earliest spring record is May 1, 1942, which is also early for its presence in the region. Our other first spring records for the park vary from May 5, 1939, to June 5, 1940.

The "chebec," so called because of its oft-repeated emphatic call, exhibits little fear of man and will permit close approach. It often chooses the vicinity of wooded lakeside camps and cottages for nesting sites. Despite these characteristics, whatever natural or artificial attractions the park terrain, trees or lake offer, apparently they are not accepted as home by this flycatcher. For, as far as we have been able to determine, it does not nest within the park boundaries.

Eastern Wood Pewee* *Contopus virens* (Linnaeus)

Length 6.5 inches. Above dark olive-brown; two fairly prominent wing bars; below white, olive-grayish on sides of throat and breast; upper mandible black, lower mandible yellowish. Similar to the phoebe but the rather prominent wing bars, absence of the tail wagging habit and the long-drawn, whistled *"pee-a-wee,"* combine to distinguish it from that and other species.

From mid-May, or thereabouts, through the hot days of July and August, this plaintive-voiced flycatcher is to be found practically every year within the confines of Washington Park. Our earliest spring record for it is May 9, 1936, but it commonly arrives a few days later. Its presence in the park throughout the summer suggests that it breeds there but we have found no nests. There are a good many dead or dying twigs on low maples and other trees in sections of the park, however, that are not much frequented by persons and it is probable that a close watch will sometime disclose nesting pewees. While we can scarcely indicate it a common species in the park, our field observations indicate that it has become more prevalent there in recent years while its close relative, the phoebe, is now less frequently seen. We recorded on August 4, 1938, "This bird has been in the park all summer where it probably nested. It has been quiet through most of July but now with renewal of song, its presence again becomes more apparent." During six and one-half hours of observation on July 26, 1942, this bird was one of 12 species listed. Then on September 15, 1943, we observed two adults with evidently one young of the year feeding from dead twigs high up in an elm tree. These summer dates furnish circumstantial evidence of its nesting in or near Washington Park.

Probably the feature of most popular interest associated with the wood pewee is its sweet melancholy note and the bird's apparently tireless efforts in uttering it even on the hottest days of midsummer. Undoubtedly its best efforts are in early morning but it also sings in the evening (sometimes with a varied song) and we have heard it at one time or another at almost every hour of the night. The three parts of the *"pee-a-wee"* song are slurred together, the first, usually highest in pitch, the second, lowest and the last, medium. Sometimes the bird sings only the first two notes *"pee-ah"* and again only the last part *"ah-wee-e"* (Saunders, 1923, p. 304). Amateur observers sometimes believe that they have heard the pewee in midwinter or very early spring. They have confused the abruptly whistled *"phe-bee"* note of the black-capped chickadee with the plaintive and slow *"pee-a-wee"* of the wood pewee. Still others question the difference of this call from the short, sharply uttered note of the phoebe. When familiar with the three calls, one should have no difficulty in distinguishing them.

On account of its rather secretive ways during the breeding season the nesting activities of this woodland flycatcher may be easily overlooked. The bird usually constructs its nest astride the fork of a horizontal limb of a tree, often a dead one, at a height of 10 to 20 feet from the ground. Partly because of its position and partly because of the lichens covering it, the nest of the wood pewee is difficult to find. The three or four eggs with a wreath of brownish spots on the larger end usually are laid in June.

Perched on a leafless twig or dead branch, usually 10 to 30 feet from the ground, the pewee patiently awaits a passing fly, wasp, bee, bug or beetle. With a quick dart and often plainly audible snap of the mandibles it seizes the prey then returns to its perch. While this bird includes in its fare a few beneficial insects, the percentage of insect food inimical to agriculture, horticulture and forestry far exceeds the beneficial forms.

Our woodlands and parks would lose some of their restful enchantment without the presence of this retiring, plaintive-voiced flycatcher.

Swallows: Family Hirundinidae

Tree Swallow* *Iridoprocne bicolor* (Vieillot)

Length 6 inches. Above steel-blue or blackish green; below white; tail only slightly forked.

In the Albany area this fairly common transient but uncommon summer resident is likely to arrive from its winter quarters about April 10th; by the last weeks in September or the first week in October the autumnal movement to the South has ended.

Washington Park, with its urban setting and single, comparatively small body of water surrounded by wooded slopes, is scarcely a suitable habitat for this or any other swallow. Our views of the tree swallow from within the park accordingly have been few. We have identified it with certainty flying low over the park on only nine occasions between April 4, 1942 and May 18, 1938. On this earliest date between 5 and 6 p.m. four individuals were circling above the lake, at times flying low. This is also an early regional date for the species. Our single record for the actual occurrence of the bird in the park is for the late afternoon of April 17, 1936. On that occasion 28 individuals, all males, together with a male and female barn swallow, were alternately coursing over the lake and resting on the high tension wires stretched above that body of water. On the following day the swallows were not to be found. Evidently the presence of the species in the park is more or less accidental although, without doubt, it flies over more frequently than our few sight records would indicate.

Like the barn swallow, the tree swallow,—sometimes called "white-bellied swallow," is an excellent flier. Before taking up family cares, tree swallows, along with our other four species of swallows, often associate together freely, hawking for insects over lakes, ponds and streams. In these travels as well as at other times the birds often fly over Washington Park and the observer should be on the alert to examine these groups as thoroughly as possible in order to determine the identity of their components.

Although the natural nesting places of the tree swallow are hollow trees or stumps and abandoned woodpecker holes, it will readily accept nesting boxes that have been placed in suitable territory, preferably open situations near water. Nesting materials consist principally of grasses, straw and feathers. The usual complement of eggs varies from four to seven.

After the breeding season young (particularly of that year) and adult tree swallows, together with other species of swallows, often congregate on roadside telephone and fence wires to rest and sun themselves. In a short time, led by the adults, they begin to wander more widely and to visit near-by swamps and marshes in search of food. In favorable situations, hundreds of swallows of all five species found in this region may congregate to roost in swamp areas and again the observer will be well repaid for close examination of these assemblages.

Approximately 80 per cent of the diet of the tree swallow has been found to consist of two-winged flies, beetles, ants and their allies, moths, true bugs, Mayflies, dragonflies and grasshoppers. A few of these insects are parasitic and predaceous and so, from the standpoint of man, are beneficial. Wild fruits, particularly bayberries, also enter into the diet of this swallow. The value of the tree swallow in the role of a destroyer of principally noxious insects, however, can not be denied and it is a bird well worthy of encouragement and protection.

Common Bank Swallow* *Riparia riparia riparia* (Linnaeus)

Length a little over 5 inches. Above brownish gray; below white with a distinct gray band across the breast; tail emarginate; wings strong and feet small and weak, similar to all the swallows.

FIGURE 28 Along this shady path on the hillside near south shore, olive-backed thrushes and white-throated sparrows were observed. May 18, 1938

FIGURE 29 Looking north over the arched bridge from the hill south of the lake. May 18, 1938

The bank swallow or sand swallow is the most abundant member of the family during the summer in the Albany region. From mid-April, when the first spring arrivals put in their appearance, to mid-September, when the last stragglers leave, this bird draws attention principally through the aggregations of nesting burrows which it excavates in the banks of roadside cuts and in sand and gravel pits. And although numerous nesting pairs occupy these burrows within the western limits of Albany, and are even more plentiful to the north and west of the city, we have recorded the species definitely on only two occasions from Washington Park.

On May 18, 1939, several individuals forming a loose group were observed flying in a northwesterly direction over the larches at the west end of the park. So low were the birds that their identity was positively established. One individual was observed on May 18, 1942, again flying low over the same trees. No doubt bank swallows frequently pass over the park, at least much oftener than our two records would suggest. We have often seen swallows thus flying, but in most instances they were high above the trees, precluding certain determination. In such flights the fork-tailed barn swallow is more readily distinguishable than any of the others. Never have we noted the bank swallow coursing over the water of the lake although, at least now and then, a few individuals must do so.

Toward the latter part of May, in this region, the local bank swallow population begins to forego its wandering proclivities and concentrate in colonies in the vicinity of sandy banks and excavations which offer a vertical surface suitable for burrow excavation. Both sexes take part in the digging very shortly after mating. Ordinarily the burrows vary in length from 24 to 36 inches; they may be shorter and we have found a few that were as long as 60 inches. The straw and grass nest is placed near the slightly enlarged extremity of the burrow and then egg-laying begins. A full complement numbers four to seven. Incubation now becomes a paramount duty, both sexes taking part in it. This activity occupies 14 to 16 days and is interspersed with forays for food and with the intermittent placing of feathers, usually white ones from the domestic fowls, in the nest to form a feather lining which is generally completed by the time the first young are hatched. The young remain in the nest for 19 to 21 days and are able to fly well on their first attempt. Incidentally, in our extended bank swallow studies we found that the temperature of newly hatched young was about 92.0°. This increased to an average of 106.24° at the time they leave the nest, which is slightly below the average of 107.1° for the adult.

Average weight for adult bank swallows is 14.3 grams. Family relationships are more or less broken following the initial flight. Gradually the young wander more widely from the natal colony and within two weeks they desert the immediate site. By late July, together with adults of their own species and both young and adults of other species, they begin flocking in reedy swamps and marshes preparatory to the southern migratory journey. Shortly after mid-August some depletion in the size of the flock is noticeable and a month later few, if any, remain.

A few years ago the senior author examined the stomachs of 21 adult and 43 young bank swallows collected in the vicinity of Oneida lake from May 14th to July 22d. A little more than 36 per cent of the food taken consisted of small dung, leaf and snout beetles. Two-winged flies of several species represented 32 per cent of the food, while true bugs (*Hemiptera*) made up about 24 per cent. Four-winged flies (*Hymenoptera*) constituted less than 6 per cent of the diet. The remaining animal matter (about 2 per cent) consisted of miscellaneous insects and spiders.

This study of the food habits of the bank swallow is in line with the results of studies of birds taken over a much wider territory. All the available evidence indicates that the presence of this lively, energetic swallow about our fields and streams is highly desirable and worthy of encouragement.

Northern Rough-winged Swallow*

Stelgidopteryx ruficollis serripennis (Audubon)

Length about 5.5 inches. Above brownish gray; below pale brownish gray, whitish on the belly; tail only slightly emarginate. Can be distinguished from the bank swallow by its slightly larger size, more generally uniform brownish gray coloration and absence of distinct brownish gray band on the breast. It also has a slower and more regular wing beat than that species and often shows white flank tufts in flight. The common name of the bird is derived from a series of minute, recurved hooklets on the outer vane of the outer primary which are "rough" to the touch. These are not visible, however, except when the bird is in hand.

This rather uncommon local summer resident among our swallows usually reaches this territory in late April and an occasional individual may be seen through September. For Washington Park we have only a single definite record, for May 7, 1940. On the morning of that day a single individual was circling about over the lake bed which was exposed by temporary draining. Several times the swallow flew so near that we were able to note its larger size, heavier body, plain grayish underparts and less buoyant flight, as compared with that of the bank swallow which it closely resembles.

Ordinarily the rough-winged swallow nests in small colonies comprised of individuals of its own species or with a colony of bank swallows. In the Albany area we have always found it nesting in solitary burrows or in a burrow in close proximity to an aggregation of bank swallow burrows. Gravel, sand or shale banks provide the ordinary nesting site. Sometimes it digs its own burrow, or uses one excavated by a bank swallow or kingfisher, and sometimes it utilizes a natural crevice in a ledge or cranny in a wall. The nest is comprised of coarse grass and lined with feathers. The egg clutch varies from four to eight.

Although it seems to have increased somewhat in numbers in recent years the rough-winged swallow is even more temperamental than the cliff swallow and less communal than the bank swallow. As yet it has not readily adapted itself to man and his structures. Probably these characteristics are responsible, in some measure at least, for its inability to attain greater numbers.

American Barn Swallow* *Hirundo rustica erythrogaster* Boddaert

Length about 7 inches. Male, above deep steel blue; below pale chestnut-rufous, the forehead, throat and upper breast darker; tail deeply forked, the feathers when spread showing a broken band of white. Female, similar but paler below; outer tail feathers shorter.

Probably this well-known bird enjoys the most general local distribution of any of our swallows and, in number exceeds all the other species with the possible exception of the bank swallow. From mid-April to mid-September it is a common summer resident throughout our rural and suburban districts.

Principally on account of its very deeply forked tail and the pale rufous coloration of its underparts, the barn swallow is more easily distinguished in flight than other swallows. Probably for this reason also we have recorded it in Washington Park more frequently than its relatives. Every year save four, 1933, 1934, 1938 and 1941, we have identified it on one or more occasions flying over the park.

Our first record here for the barn swallow was obtained on May 8, 1935, when a single individual was seen coursing low over the lake as if it were hawking for insects. This day was further notable for this bounded city area in that many other barn swallows were flying above the tree tops in a westerly direction, sometimes singly, but mostly in groups of from three to ten individuals. Evidently this marked "flight" consisted principally of individuals that had moved up the Hudson river and were dispersing from this flyway westward along the Mohawk river. On only two of the eight remaining regular early morning field trips of 1935, did we record the barn swallow.

In 1936, our only park record for this bird was obtained on April 17th, when a male and female were seen with the notable aggregation of 28 tree swallows perched on the high tension electric wires stretched above the waters of the lake. This is a fairly early spring date for the barn swallow in the region. Incidentally, also, this is the only time that we have viewed the bird at rest in the park. Our banner year for barn swallows was 1937, when on five of the 13 trips taken between the inclusive dates April 21st and May 16th, one or more individuals were sighted feeding over the lake or hunting above the surrounding trees. On the morning of May 15th, a loose group of twelve individuals, both males and females, accompanied by a single northern cliff swallow was coursing about over the waters of the lake in search of food; this was the largest flock that we observed within the park borders.

Our first seasonal barn swallow record for the park in 1939 was May 3d, and in 1940, it was April 27th. On only two occasions during each of these spring seasons and also those of 1942 and 1943, did we note the bird. One of the records for 1942 was April 29th, when a male and female spent some time coursing over the lake. Our only summer sight date was for August 12th, but with more intensive observation, we doubtless could have noted others.

In common with the other representatives of the family, the barn swallow is more or less social, not only with reference to its own kind, but also in relation to man. For the most part it seems that man recognizes at least the inoffensive qualities, if not the utilitarian potentialities, of this bird which is generally regarded with the friendliness it deserves.

This swallow possesses a weak musical twitter often uttered on the wing. It is an excellent flyer, adept at circling, side-slipping, darting and other aerial maneuvers. Often it skims along close to the ground or surface of the water in its search for insects; sometimes it even dips lightly into the water in its effort to capture them.

Following the usual prenesting wanderings, the barn swallows in this territory usually select nesting situations in barns and other farm buildings in or adjacent to open country. Rafters, beams and wooden supports of various kinds are favorite nesting places. Caves and highway bridges are utilized to a lesser degree. Two to ten or more pairs frequently occupy the same nesting site. The nests are made of mud pellets and straw with a lining of fine grass and feathers. Contrary to the practice that characterizes the bank swallow, the feather nest lining of the barn swallow is completely placed before egg-laying begins. Four to six whitish eggs, heavily spotted with brown comprise the usual complement. In our growth studies, we have found that the average temperature for one-day-old barn swallows was 97.45° and that it increases to about adult average of 107.0° when the birds are ready to leave the nest. Average weight of three adults was 19.63 grams.

From July 1st on through the summer, adults and young of the year frequently associate in numbers on roadside telephone and electric wires. Here the adults often may be observed delivering food to their now well-developed offspring which are entirely capable of flight. As summer wanes the adults are first to congregate in the outlying swamps and marshes; within a few days they are joined by young not only of their own species but also of cliff and tree swallows and, perhaps, a few bank swallows. The latter, however, are less prone to mingle with groups comprised of individuals of other than their own species. Daily the numbers in favored localities near reedy marshes are augmented, the birds coursing about singly or in small groups in search of food, and nightly repairing to the tall grass and rushes to roost. By mid-August an obvious exodus is apparent and during the immediately following fortnight the southerly movement reaches its height. Locally this late summer movement is particularly well-marked along the Hudson river south of Albany.

Practically all the food of the barn swallow consists of insects which are captured on the wing; in this activity the species is both diurnal and crepuscular. Beetles, true bugs, two-winged and four-winged flies (*Diptera* and *Hymenoptera*), moths and Mayflies are the principal kinds of insects taken. As far as man is concerned most of these forms are harmful or at least bothersome.

On the whole the behavior and economic importance of the barn swallow deserves a high rating and the bird is altogether worthy of the consideration from man that it usually receives.

Eastern Cliff Swallow*

Petrochelidon pyrrhonota pyrrhonota (Vieillot)

Length 5.5 inches. Above, crown and back steel blue; forehead whitish; collar and upper tail coverts pale rufous; throat and sides of head chestnut; breast brownish gray with a steel blue center patch; belly white; tail slightly emarginate.

Although the eastern cliff swallow is sometimes a moderately common summer resident in the Albany region and perhaps more common as a transient in the fall, we have definitely recorded it on only two occasions in Washington Park. On the afternoon of May 15, 1937, a single individual was coursing over the lake in company with a small group of barn swallows and on May 7, 1946, the junior author saw two birds circling with a group of barn and tree swallows over the west end of the park.

Without doubt the cliff swallow flies over the park low enough for positive identification much oftener than our records indicate. And, now and again it may even course over the lake in search of insects.

Undoubtedly the advent of man and his works upon the formerly uninhabited country has left its impression upon the cliff swallow. For now it has largely forsaken its original nesting sites such as caverns and cliffs and has taken up quarters in or about human habitations where its breeding activities are too often molested. If and when this occurs some of the birds of a nesting colony may take up nesting quarters elsewhere to rear a brood. Others may be so disturbed that they wander about as nonbreeders. Often both man and the English sparrow exert unwelcome influence. The net result of all this is that the stability of a large number of individuals is jeopardized, breeding activities are disturbed or carried on with difficulty, and the birth rate thereby is materially reduced. So, despite the fact that an apparent abundance of suitable nesting places are available the species appears to be engaged in a losing fight to maintain its numbers.

On the average, the cliff swallow reaches the Albany area a little later than its relatives. Seldom is it recorded before April 25th. By mid-September most have departed for the South. In spring these swallows associate with the barn, bank and tree swallows but as the nesting period approaches they become definitely localized in certain farmyards or other selected territory.

Each summer in the Albany area we find at least several small colonies of nesting cliff swallows. Not only does the size of the colony fluctuate from season to season but also the colony may shift from one neighborhood to another, particularly if the nesting activities of the preceding season have been interrupted. In our life history studies carried on for many years in this vicinity on the cliff, barn and bank swallows, we found that the average weight in grams for adults of these three species was, respectively, 23.83, 19.63 and 14.56. The flying ability of these three near relatives seems to be proportional to lightness of weight.

The mud domiciles of the cliff swallow, closed to the exterior save for a small opening, are usually placed under the eaves of buildings and lined with grass and feathers. Several of these nests may be placed side by side. The greatest number that we have seen in the Albany area so placed was 66 (Stoner, 1945, p. 207-16). The four or five white eggs are speckled with brown.

The note of the eastern cliff swallow is a harsh chirp. In flight this bird lacks some of the ease and agility so characteristic of the barn swallow. It is also decidedly less belligerent than that species.

In late summer cliff swallows associate with barn swallows and other representatives of the family on roadside wires and in rush-grown swamps. This premigratory flocking often affords the observer an opportunity to compare our several species of swallows at a glance.

In common with other species of the family the cliff swallow has a relatively small and weak bill but a wide gape. It follows then, that the food must be taken largely on the wing and that the principal food items must consist of small insects. As with the other swallows, too, most of these insects are harmful in relation to man.

The habits of this bird are neither injurious nor particularly obnoxious to man. The popular belief that cliff swallows harbor bed bugs on their bodies or in their nests has no foundation in fact. They have a similar parasite but it does not transfer to man. It is well that a onetime too prevalent practice of destroying the birds' domiciles has ceased for this desirable inhabitant of our farmyards is worthy of better treatment.

Crows, Jays Etc.: Family Corvidae

Northern Blue Jay* *Cyanocitta cristata bromia* Oberholser

Length nearly 12 inches. Above grayish blue; black crescent in front of eye and black band on back of head; sides of neck and across breast, black; head crested; wing feathers largely blue, greater wing coverts and secondaries barred with black and tipped with white; tail feathers blue barred with black, all except middle pair, broadly tipped with white. Below dusky-whitish, paler on the belly.

The shades of blue predominating in the blue jay's color pattern are so harmoniously mingled and blended with black and white as to produce a contrasting yet pleasing effect. The attractiveness of this beautiful and vivacious bird is heightened by the conspicuous, erectile crest.

At times of the year other than the nesting season the blue jay is likely to be found in almost any type of situation. Even the wooded sections of Washington Park are visited by this handsome fellow occasionally. Indeed, on none of the thirteen field trips taken during the spring of 1934 did we record the jay. On the other hand, in 1938, we saw it on 13 of our 34 field trips. Fifty-five of our 64 field records for the species have been in May, six in April, two in June and one in October. The largest number of jays observed at any one time was on the morning of May 13, 1942, when a group of 17 individuals flew in a northerly direction, single file, over the west end of the park not far above the tree tops. Other groups of two, three, eight and 15 individuals have been recorded flying over.

In Washington Park we have often heard the shrill, high-pitched *"jay, jay"* at some distant point before the vocalist itself was detected. This note has remarkable tonal and carrying powers. In spring, particularly, the first excited cry of one of these noisy, nervous and belligerent birds often serves to bring together a number of its kin, perhaps to attack a luckless crow or owl or to examine some suspicious intruder, man or other animal.

The blue jay possesses a limited mimicking ability and can imitate the robin, crow, starling and red-shouldered and other hawks, as well as other birds with a reasonable degree of fidelity. On occasions it can utter a rather pleasing low, soft warble.

The blue jay ordinarily flies at no great height and maintains a direct course over short distances as from one tree to another or between the wooded tracts which it is accustomed to haunt.

As suggested by Eaton some thirty years ago (1914, p. 208) this jay can be found in almost any part of the State at any time of year. More or less of a spring and fall movement, however, does occur. Banding studies have shown not only a north-south migration but also an east-west movement. So, although we have blue jays with us throughout the year, probably for the most part different individuals make up the local population in summer and winter. In this area the spring movement is not under way until after the first few days in May. No doubt this accounts for the marked preponderance of our records during that month.

The blue jay likes woodlands; after the spring movement has ceased, it repairs to yards of farm homes or to stands of mixed timber where it builds a platformlike stick nest close to the trunk of an evergreen or some other tree. Four to six eggs comprise the usual complement.

In food habits the blue jay is indiscriminate. Woodland mast and wild fruits of many varieties form the principal vegetable items of its diet. Such insects as beetles, moths, butterflies, grasshoppers and *Hymenoptera* constitute the chief portion of the bird's animal diet. By way of offsetting the desirable traits, from man's standpoint, the blue jay has the undesirable habit of feeding upon both the eggs and young of other birds. Where local conditions seem to demand it, however, the situation usually can be remedied by eliminating the proven few offenders and leaving unharmed those individuals which may not be participants in jay misdemeanors.

Eastern Crow* *Corvus brachyrhynchos brachyrhynchos* Brehm

Length about 19 inches. Above and below black, the upper plumage with purplish reflections, the underparts duller.

Every one knows the ubiquitous crow. It shares with the blue jay a belligerent, aggressive and quarrelsome nature. It is common and widely distributed in and about wooded districts and breeds in every county in the State. Its general characteristics, voice, feeding habits and economic relations are so well-known and so much has been written about them that the reader is referred to one or more such accounts for detailed information on these subjects.

As a species the crow is a permanent resident in the Albany region but it exhibits well-marked seasonal movements and, in winter, definite flights between roosting places and feeding grounds occur, at which times the gregarious tendencies of the bird are particularly well-displayed. The crow also is social on its feeding grounds, whether a mud flat along the river, an open field where it seeks waste grain in winter, or a newly sprouted corn or other grain field. During the breeding season, too, several pairs of breeding birds are likely to occupy nesting territory in a circumscribed woodland plot.

It is during the spring and fall flights that the crow is most frequently observed from Washington Park. In only a relatively few instances have we observed crows actually in the park. Occasionally one or two will detach themselves from a group flying over to rest for a time in a tall tree, broadcasting a characteristically defiant, loud, harsh *"caw, caw."* Perhaps one of the birds may walk along the shores of the lake in search of a bit of food. Usually, however, the bronzed grackles discourage any protracted stay by pooling their own belligerent tendencies so effectively that the larger bird is glad to effect his getaway.

From mid-March through April the early morning spring movement of crows over the park is at its height. The prevailing direction of flight appears to vary from season to season but usually it is from southeast to northwest in spring and the reverse in fall. The spring flight ordinarily takes place at a lower altitude than that of the autumn. Small loose groups of from two to ten are most common although larger flocks of from 50 to 200 or 300 or more individuals have been seen. Recorded in the senior author's notes for March 17, 1944, is the following: "This evening between 5.15 and 6 p.m. Eastern War Time, I counted 770 crows flying in a northwesterly direction over the park and its vicinity, some high, some low, loose straggling groups. Perhaps a minute might elapse when none of the birds could be seen. I would estimate that at least 400 to 500 more crows passed over uncounted. Wind was moderate, northwest, partly cloudy. One of the largest flights that I have seen." The autumnal movements usually take place in a more leisurely manner, at a greater height and sometimes involve a greater number of birds in each group; one such flight that we witnessed about 8 a.m. on October 21, 1940, contained a combined counted and estimated number of more than 500 individuals. These autumnal flights continue into November.

Some proportion of both spring and fall flocks probably represents migrating individuals; for as indicated above, a certain amount of seasonal shifting of our local crow population occurs. Recent banding studies have thrown some light upon these movements. The majority of the flights over Washington Park probably are participated in by birds dispersing from nightly concentration roosts in some near-by woodlands to feeding grounds along the Hudson and Mohawk rivers, to which roosts they return later in the day.

Isolated mixed and deciduous woodlands are frequently chosen as nesting territory by crows. The bulky nests of sticks, twigs and bark are usually built in the fork of a tree at a height of 20 to 50 feet above the ground. The eggs vary in number from three to five. After an incubation period of about 18 days, the blind and naked young are hatched; a period of three weeks is passed in the nest before they are able to leave. As time for departure approaches, the young become exceedingly vociferous and the adults voice freely their own solicitude for the offspring.

Although we did not find any nest in the park we strongly suspected the crows were preparing to nest there in 1942, because on April 4th, 14th and 18th, individuals were seen carrying nest materials toward the same locality. Three and five days later birds were observed in the same section of the trees. In fact, they were observed in the park 15 times and flying over on four other dates in this year.

The extensive investigations of E. R. Kalmbach of the U. S. Fish and Wildlife Service (formerly in part the Bureau of Biological Survey) have done much to elucidate the economic status of the eastern crow. His statements and recommendations were made on the basis of examination of 2118 stomachs of young and adult crows taken throughout the year in 39 states, the District of Columbia and several Provinces of Canada, and after reviewing more than 3000 letters of inquiry. The following is an excerpt from his report on The Crow and Its Relation to Man (1918, p. 85-86):

> "When feeding on injurious insects, crustaceans, rodents, and carrion, and when dispersing seeds of beneficial plants, the crow is working largely for the best interests of man; when destroying small reptiles, amphibians, wild birds, poultry, corn, and some other crops, when molesting live stock and distributing their diseases, and when spreading seeds of noxious plants, the bird is one of the farmer's enemies; when destroying spiders and mollusks, however, its work appears in the main to have a neutral effect. The misdeeds of which the crow has been convicted greatly outnumber its virtues, but these are not necessarily equal in importance. Much of its damage to crops and poultry can be prevented, while the bird's services in the control of insect pests can ill be spared. At the same time no policy can be recommended which would allow the crow to become so numerous that its shortcomings would be greatly accentuated. As the capabilities of the crow for both good and harm are great, it is believed that an extermination of the species would have ultimate consequences no less serious than an overabundance."

Titmice: Family Paridae

Black-capped Chickadee*

Parus atricapillus atricapillus (Linnaeus)

Length 5 inches. Above ashy-gray; below white, the sides and flanks tinged with buffy; crown, nape and throat black.

No bird is more welcome about our parks and homes than this hardy, cheery permanent resident. Its inquisitive yet trusting nature, its restless disposition and its cheery *"chickadee-dee-dee"* the year round, and its less familiar *"phe-bee"* note, sometimes mistaken by the uninitiated for the call of the phoebe or the wood pewee, combine to render the black-capped chickadee one of our most popular birds.

Although we found the chickadee moderately common in the Albany region, our observations in Washington Park indicate that it scarcely has that status there. For, in the 34 morning field trips taken in 1935 and 1936, and 41 trips in 1941, we failed to record the bird; in the three seasons of 1934, 1939 and 1940, with a total of 73 trips, we reported the bird three times, once each season! In 1933, we observed the chickadee on only two of our ten trips. Our banner years were 1937, when we recorded it on 15 of our 26 trips, 1938, when it was noted on 11 of the 34 trips, and 1942 when it was listed on 16 of 43 trips; apparently a single bird remained about the larches at the west end of the lake from April 18th through early May. Stragglers or wanderers may occur in the park almost any time; most of our records are for the month of April when small loose groups of from two to six or eight individuals often exhibit concerted, prebreeding movements.

The social habits of the chickadee are apparent at most times except during the breeding season. The bird is partial to mixed woodlands such as maple, birch, hemlock tracts, and in these situations a hiker is likely to be followed by several of these friendly, fluffy little fellows. Often he can induce them to come quite close by imitating the low, whistled *"phe-bee."* Although the latter note is most frequently uttered by the chickadee in winter and spring, it may be given at other seasons as well.

Following a period of exploration and wandering in the spring, the chickadees pair, several pairs often selecting nesting territory within a short distance from one another in some wooded tract. Sometimes they excavate their own nest holes in dead birch or other stubs, decaying fence posts, and the like; the entrance is about one inch in diameter and may be from three to 20 feet above the ground. Often abandoned holes of woodpeckers are utilized. Nest materials consist of grass, moss, plant down and feathers. The usual clutch of five to eight eggs is likely to be laid between mid-May and mid-June.

After the breeding season the birds again become sociable and spread into the adjacent open country and cultivated areas where they often attract attention by their notes and acrobatics.

About one-third of the chickadee's food consists of mast and wild fruits. The remainder of the diet is made up principally of caterpillars and eggs of moths and butterflies, spiders, beetles, true bugs and four-winged flies (*Hymenoptera*) of many kinds.

Our orchards, forests and parks profit well by the presence of this energetic bird. Not the least of the benefits conferred is its destruction of so many insects in both the undeveloped and dormant state: this reduction in the numbers of insects during winter lessens likelihood of spring injury to the vegetation and the outbreak of serious damage later on. Moreover, the chickadee's pleasing voice and appearance help to render it a general favorite. And its popularity is further enhanced by its ready response to proffered food at winter feeding shelters and stations.

FIGURE 30 The group of larches in background, left of center, is one of the best places in the park to observe kinglets, goldfinches and warblers. May 3, 1938

FIGURE 31 Top of larches, where crossbills, warblers and other birds were observed. May 14, 1941

FIGURE 32 Small beach at northwest corner of the lake is used as a bathing and feeding place by grackles, robins and other birds. October 10, 1938

Nuthatches: Family Sittidae

Eastern White-breasted Nuthatch*

Sitta carolinensis cookei Oberholser

Length 6 inches. Above bluish gray; top of head and neck black; below white. The short legs, squat appearance, arboreal proclivities and habit of descending a tree headfirst, together with its characteristic nasal *"quank, quank,"* are helpful field characters.

In numbers, the white-breasted nuthatch scarcely can be indicated as a common bird either in Washington Park or in the Albany region. Nevertheless, it is so generally distributed locally that the observer is likely to acquire an exaggerated notion of its abundance. To illustrate this feature we may say that from the standpoint of frequency of occurrence on our regular field trips in the park, the white-breasted nuthatch ranks 11th in the list, having been recorded on 138 of 250 trips taken 1933 to 1942 inclusive. Seldom on a single trip did we see more than two or three individuals. As far as actual numbers are concerned, then, this bird probably is surpassed by 35 or 40 other park species. In only one season, 1935, did we fail to record the white-breasted nuthatch; the highest frequency occurrence rates were in 1938, when we observed the bird on 31 of our 34 regular trips, and in 1939, on 25 of the 28 formal field trips.

The climbing ability of this bird is familiar to most persons. It keeps close to the trunks and larger limbs of trees and climbs up, down or around them without supporting the body by the tail as do the woodpeckers. A self-satisfied nasal *"quank"* often provides the vocal accompaniment for these explorations. In Washington Park and elsewhere on several occasions we have come upon individuals scattered among the trees in a circumscribed area, uttering these notes at such frequent intervals as to suggest a conversational chorus.

This permanent resident is at home in woodland, swamp, orchard or village and, indeed, it is one of the few native birds to nest in Washington Park. Ordinarily this nuthatch nests early in the season, in May and early June. A hollow stump or tree or an abandoned woodpecker's hole often serves as a home. Leaves, grass, moss and a lining of feathers comprise the nest material. The usual complement of eggs is five.

The white-breasted nuthatch will accept nesting boxes properly placed for it. Indeed most of our 1938 Washington Park observations centered around a pair occupying a nesting box 30 feet up in the crotch of a large maple tree on the north side of the lake at the approach to the bridge. A well-traveled foot path lay directly below this weather-beaten box, which evidently had been placed in an attempt to encourage a pair of northern flickers. The entrance hole was about two and one-half inches in diameter. Some of the field notes of the senior author on this nesting are:

"May 2d. This morning, after the nuthatch outside had made its presence known by a series of rapid *"quanks,"* the bird inside the box appeared at the opening and accepted food from the one on the tree trunk. I believe that this pair of nuthatches is incubating eggs or brooding young.

"May 4th. Saw one adult carry and deliver a bit of food to another adult *in* the box; the latter came to the opening to receive it when the bearer uttered a soft nasal *"quank."*

"May 5th. One adult carried from the box a large white object, possibly a pellet of excrement or a bit of eggshell. Have the eggs hatched?

"May 6th. One adult feeds the bird in the box as on preceding observations. Fragments of white egg-shell lie on the ground at the base of the tree. Has a starling or other bird partially succeeded in robbing the nest? At 10.30 this morning obtained a ladder and climbed to the nest box. Well back therein was a flattened nest composed principally of fine shreds of bark, fine grasses and a few dead leaves. With the aid of a flashlight I could detect two eggs. Evidently part of the clutch has been destroyed, probably by a starling."

On May 7th, 9th, 11th, 12th, 13th and 14th, we observed one of the adults call the incubating bird to the box entrance one or more times and deliver food. On May 16th both nuthatches were transporting food to the nest box. Evidently the young had hatched; this event must have transpired since our early morning trip two days earlier. On May 31st, the adults were still carrying food to the nest box but on June 3d, the box was deserted; probably the juvenals left it on June 1st or 2d.

Possibly owing to the ever-increasing prevalence of the starling the white-breasted nuthatch was less common in the park in some of the years thereafter. On May 15, 1939, however, a pair was discovered nesting about 20 feet up in a maple tree 50 feet north of the lake and park house. The nest hole was in a decayed area of the trunk at a point where a limb had broken away. As in the previous season we observed one adult deliver food to the incubating individual. As late as June 7th the adults were still carrying food to the young which, however, must have been almost ready to fly.

Again on April 24, 1942, both sexes were observed with nesting material entering a knot hole in a partially decayed limb about 18 feet up in a soft maple tree near the park bridge. On the following day we witnessed a demonstration of the interesting defensive behavior of the pair. Both birds were still busily engaged in construction. The following excerpt is repeated from *The Auk* (1943, p. 95-96):

> "The male had just delivered to the female within the nest cavity a small amount of material that appeared to consist of the frayed vane of a delicate feather when the proceedings were interrupted by the presence of a prowling northern gray squirrel (*Sciurus carolinensis leucotis*).
>
> "Slowly and somewhat hesitatingly the squirrel ascended the limb toward the nest but at once the male nuthatch uttered a low alarm note and forthwith fluffed out his body feathers to their full extent. Still the squirrel came on. Then the male nuthatch, with all the contour feathers elevated and spread, and the wings extended as completely as possible, began a steady, rhythmic, side-to-side swaying movement, the while advancing toward and retreating from the now irresolute squirrel. Neither the bird nor the squirrel uttered a sound audible to the observer a few feet away. Presently the female nuthatch emerged from the nest opening and joined her mate in the feather-elevating and rhythmical swaying of her body.
>
> "Both nuthatches remained close together on the limb, the female more or less completely covering the opening to the nest cavity with her body and extended wings. This performance was continued for three to four minutes. The sight of these two suddenly enlarged birds with contrasting black and white coloration, rapidly vibrating wings, and threatening demeanor brought the squirrel to an uncertain halt; then a well-directed peck from the still quivering male nuthatch prompted the intruder quickly to take his departure from the scene.
>
> "While the birds themselves may have been in no acute peril from the squirrel, their mutual assumption of this unique oscillating attitude, similar to that sometimes employed in mating performances, obviously was effective in discouraging the presence of a larger, unwanted animal, which *threatened* real or at least imaginary danger."

Evidently construction on the above nest continued through May 1st in this year (1942). When we tapped on the tree trunk on May 18th the female appeared at the opening; the male then brought her a grass stem; and on June 3d she was seen approaching her domicile with food for the young birds which evidently were inside. Both adults were seen feeding the young out of the nest in a near-by tree on June 13th. This gives evidence of the third year that young were reared in the park.

The principal vegetable food of the white-breast includes beechnuts, acorns and other mast. Its animal food consists largely of beetles, caterpillars, moths, ants, flies, grasshoppers and spiders. Most of these forms are injurious to forest and shade trees, so this bird is an ally of man in combating them. This bird, too, can be readily attracted to feeding stations in winter and thus provides diversion and entertainment for many persons at a season when our feathered friends are reduced to their lowest numbers.

Red-breasted Nuthatch* *Sitta canadensis* Linnaeus

Length about 4.5 inches. Above bluish gray; top of head and broad stripe through eye to nape, black; white line over eye; below pale buff except on that which is white. The smaller size, buffy underparts, black line through eye and higher-pitched, less vigorous, nasal *"yna-yna-yna"* distinguishes it from the white-breasted nuthatch.

In the Albany region the red-breasted nuthatch is considerably less common and more cyclical in its occurrence than its white-breasted relative. Probably it could be found here in every month of the year but it is most likely to be seen between early April and mid-May and again in September and October.

In Washington Park we have recorded this nuthatch on only 40 of the first 250 regular, early morning field trips. Seventeen of these records were obtained on the 28 field trips taken between March 24 and May 18, 1938. We have only a single record for 13 trips in 1934, two each on 20 trips in 1936 and 32 trips in 1940, and three for 32 trips in 1942, which makes a total of eight listings on 97 trips for those years. We did not see it on a total of 78 trips taken in 1933, 1935, 1937 and 1939. In 1938, the bird appeared to reach the peak of abundance the first week in May. On several of our early May trips of that year we noted from three to six or more individuals; our latest spring record for the park is May 20, 1940, when both a white-breast and a red-breast were observed at the same time 35 feet from each other on a large elm tree. During May the species was often observed in pairs. Its liking for the vicinity of coniferous growths is attested by the fact that we have most frequently noted it in or about one of the three principal tamarack clumps in the park.

In 1941, we first saw a single bird south of the lake on April 7th. Earlier this year, this smaller nuthatch had been reported from the park by various people at different times so that at least an occasional individual may have been here since late autumn or early winter. We reported it (often a single female) on a total of 15 mornings on the 41 trips taken in 1941. On April 28th, four or five were noted high in the trees evidently indulging in mating antics. Then a week later several individuals were again seen and we recorded that the species had been commoner this season than in any other since 1938.

The red-breasted nuthatch does winter in the Albany region in small numbers. Ordinarily it breeds in the Canadian Zone, coniferous forests in the Adirondacks and the Catskills. It is fond of the seeds of pines, spruces and allied trees. Its animal food is known to include beetles, four-winged flies and spiders.

While this nuthatch is similar to the larger white-breast in form and habits, its smaller numbers and more retiring habits preclude its usurpation of the place held by the white-breast in local popular esteem.

Creepers: Family Certhiidae

Northeastern Brown Creeper*

Certhia familiaris americana Bonaparte

Length 5.5 inches. Above mixed buff, blackish and white with pale rufous rump; below white. The general wood-brown coloration, slender, decurved bill and long, pointed tail feathers which aid in supporting the bird while climbing are additional field characters. The creeper's habit of alighting at the base of a tree and of working upward in a spiral course, then moving to the base of another tree in a swooping flight, there to repeat the performance is distinctive. Its sharp *"tseet, tseet"* note may be easily missed or taken for some other sound.

This unobtrusive little "study in brown" usually is a fairly common transient and winter visitor in the Albany region from late March to mid-May, and from September through November transient representatives of the species are with us; now and again a wintering individual is seen. And, although we have no concrete evidence, we suspect that the brown creeper nests in some of the remote gullies and swamps in high country not far from Albany where near-Canadian Zone conditions prevail.

Perhaps on account of its unobtrusiveness it may have been overlooked by us in Washington Park. The fact remains, though, that on only 36 of the 250 regular morning trips, which comprise the basis for this report, did we record this bird. We failed to see it in 1933, 1934 and 1940; then in 1935, 1936 and 1937, we noted it on only nine out of a total of 63 study periods. The best seasons were in 1938, when we observed it on eight of the ten trips taken between March 22d and April 24th, and 1939, when we recorded it on each of eight trips made April 15th to May 1st. On several occasions in 1938, when it was apparently more numerous than in any preceding or succeeding years, as many as three individuals were noticed in one morning, and on April 16th, ten creepers were observed in one and one-half hours time within the park boundaries. The species was not very prominent in 1941, either in number or days seen, and it may have been the same bird that was listed on three mornings on four consecutive days beginning April 16th. We have seven records between April 11 and 28, 1942. Our earliest and latest spring dates were March 24, 1938 and May 2, 1936, respectively.

As suggested by the above records the northward movement of the creeper is most marked in this territory in the latter half of April. The bird occurs commonly in the upper Catskills and the Adirondacks in June and July but in other parts of the State its presence in summer is purely local. We have found it nesting at Oneida lake (Stoner, 1932).

The brown creeper obtains most of its food from the bark and crevices of trees. Such insect forms as weevils, leaf beetles, true bugs, plant lice, scale insects, small four-winged flies and moths together with spiders comprise a large part of its diet. It takes also the eggs, larvae and pupae of many kinds of insects. Due to its searching minute crannies, the creeper discovers many well-hidden insects and their eggs that are likely to be overlooked by larger birds. It is a valuable ally of the forester and the horticulturist. In winter the creeper responds readily to food, especially fats, suitably placed. Thus attracted it supplements the wildlife that is with us during the cold months and provides diversion and pleasure for any who will cultivate its acquaintance.

Wrens: Family Troglodytidae

Eastern House Wren* *Troglodytes aëdon aëdon* Vieillot

Length 5 inches. Above cinnamon-brown, brighter on the rump; back with indistinct blackish bars; wings and tail finely barred; below grayish white. Additional characters are the energetic actions, the bubbling song, and the short tail which is often held erect.

This well-known, noisy, belligerent wren is a moderately common summer resident in the Albany region. The first spring arrivals seldom reach us before May 1st; rarely is one seen later than October 1st.

With the single exception of 1934, we have recorded the eastern house wren from Washington Park at least once each season since 1933. The highest relative frequency of occurrence was recorded in 1939, when we noted it on 21 of our 28 regular field trips; in 1938, we observed the bird on 23 of 34 trips. In 1940, we listed it for the first and only time on June 7th. That year the wren was so scarce throughout the entire capital district that it was the subject of frequent comment. Our earliest seasonal records are April 24, 1938 and 1939, and these are unusually early arrival dates for the species in this locality.

We have heard and seen the house wren much oftener in the shrubby tangles of the back yards of private residences near the park than in it. The lack of such retreats in the park, due to the more or less formal treatment of the bushes there, leaves something to be desired as house wren habitat. Perhaps also the wren houses which have been erected in neighboring back yards serve to divert the birds from the park. On June 7, 1939, the vociferous singing of a wren from the vicinity of one of these nest boxes provided reasonable circumstantial evidence that the bird was nesting there. In the park we have seen the house wren most frequently in and about the shrubbery and dead limbs of tall trees along Willett street and at the northwest corner of the park near Thurlow terrace.

The eastern house wren is a persistent and vigorous songster both before, during and to some extent after, the nesting period. Beginning with a rather monotonous succession of short, rapid notes, the song continues with bubbling enthusiasm as the singer trembles from stem to stern in the vigor of his rendition; the pitch of the notes then diminishes following the climax of the utterance. A high perch is often chosen by the performer.

Probably the house wren utilizes a more bizarre assortment of nesting places than any of our common birds. Not only does it readily accept man-built domiciles properly placed for its convenience, but of its own accord selects old shoes, twine boxes, tin cans and pockets of old clothes left hanging outdoors, as well as crannies and cavities in old buildings and trees. A bulky nest usually of twigs, some of them remarkable for their size, is lined with grass, feathers and other soft materials. A great variety of unusual objects often go into the nest structure. The usual complement of eggs is six or seven and in this territory two broods of young are commonly reared each season.

Without doubt the house wren destroys both the eggs and young of other small birds. Its pugnacious and belligerent tendencies must be admitted. It appears to require more food than the average bird of its size and the young also are fed at more frequent intervals than the nestlings of most species. These habits coupled with the highly insectivorous qualities of the bird mitigate the destructive proclivities of the house wren in relation to other birds.

Studies of the food habits of the house wren conducted by the former United States Bureau of Biological Survey and reported by McAtee (1926, p. 82-83) indicate that over 98 per cent of the diet of this bird consists of animal matter; of this, half is composed of beetles and grasshoppers, many of which are injurious to forests or other vegetation of economic importance to man. Other insects taken are two-winged flies, Mayflies, dragonflies and crickets; additional invertebrate forms that are eaten include millipeds, spiders, sowbugs and snails. Field observations indicate that the birds do not range far from the nest in search of food. On this account the presence of a nesting pair or two of this vivacious little species is an economic asset about a garden or orchard or park despite its nest pillaging tendencies.

Thrashers Etc.: Family Mimidae

Catbird *Dumetella carolinensis* (Linnaeus)

Length 9 inches. Above and below slaty-gray; crown and tail black; under tail coverts chestnut.

Toward the close of April, from bushy shrubbery along roadsides or about our homes or from thickets bordering woodlands, a catlike *"mew"* announces the presence of this common summer resident. It is here from then to mid-October. The alert but somber-plumaged catbird mocks and scolds or renders a pleasing song from the depths of tangled growths throughout the capital district.

In point of relative frequency of occurrence the catbird ranks 17th, having been recorded on 107 of the 250 trips taken during the first ten years of this study. Our earliest spring date for the park is May 1, 1941; other early records are May 2, 1942, May 3, 1933, May 3, 1938 and May 4, 1936. All our other seasonal first dates lie between May 10th and May 15th. After May 10th, the observer may expect to find the catbird regularly either in the park or in the thickets of some of the back yards in the immediate vicinity. Early in the season four to six or more individuals are likely to be seen or heard on a morning trip.

The park bushes are trimmed too closely to offer sufficient nesting inducements for many catbirds; nevertheless, they visit the park for food and at least one can usually be heard singing therein at almost any hour of the day during the nesting season. As indicated above, in some of the back yards of adjoining private residences bushy growths are more profuse and offer attractive cover.

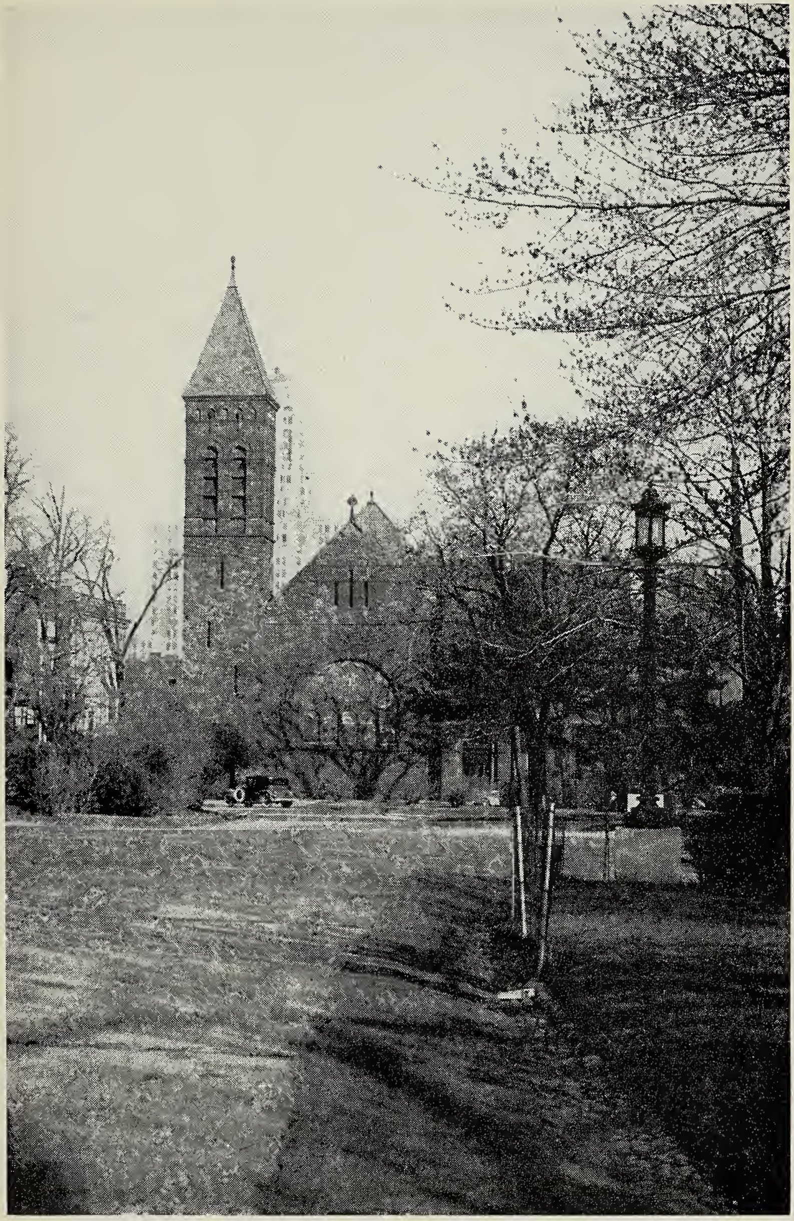

Figure 33 In the belfry of this church, at the northeast corner of the park, a barn owl nested in 1936. May 5, 1938

FIGURE 34 Eastern nighthawk nests on top of building near the park. Photo by E. K. Karcher jr

On May 30, 1941, however, a pair was seen carrying nest material from forsythia bushes located at the end of Thurlow Terrace, on the north shore of the lake. Then on the 25th of June we found a nest containing four nestlings seven to eight days old. This domicile was six and one-half feet up in a spirea bush in the parking center of Thurlow terrace, and was about 150 feet north of the above mentioned forsythia bushes. One bird (about eight days old) jumped from the nest and fatally injured itself as we approached the shrubbery and is preserved now in New York State Museum as specimen No. 6241. The other three were provided with aluminum bands of the United States Department of the Interior, Washington, D.C. The bands which were placed on the left tarsus of the nestlings had the following numbers on them: 35/128935, 35/128936 and 35/128937. The temperature, weight and seventeen measurements of feathers, bones etc. were noted for each of the young on this date, and again two days later when they were nine to ten days old. No young were found on our next visit three days thereafter. The nest materials were sticks and bark of grapevine loosely placed and the entire structure was precariously poised in the bush.

The next year on May 14th, a pair had just started a nest in one of the bushes in the same locality but some 30 feet nearer the lake. When found it consisted of half a dozen sticks and a small piece of paper. One of the birds, the female, was observed carrying a piece of white paper while the male sat near-by and sang with great fervor.

On May 26, 1943, a pair had started building a nest in the lilac bushes near Lake avenue. It was found some time later that this nest had been destroyed. A pair, perhaps the same birds, remained persistently about the bushes east of here, near the north entrance to the lake bridge for some time.

The catbird is an energetic, saucy bird that usually remains well-concealed in thickets even when uttering its song. Its best efforts in vocalization are, on the whole, pleasing, though much broken in time and quality and variable in pitch. Their vocal expressions more or less resemble those of the brown thrasher but are a little softer and mellower in tone, and are not repeated as often. Included in the bird's vocal repertoire are not only proficient imitations of the *"mew"* of a cat but also of various species of songbirds. On occasions also it utters a series of harsh, scolding notes.

Owing to its tendency to make comparatively short flights at low altitudes in search of food or for other objectives, the catbird often crosses shrub-lined highways where it is sometimes struck down by passing motor cars. Throughout the capital district in recent years we have noted an ever-increasing number of such casualties; some of the victims now repose in the Zoological collections of the New York State Museum as study skins, for example, Nos. 6136 and 6138. Undoubtedly the comparatively slow flight speed of the bird and its apparent inability to gauge properly the speed of the oncoming automobile are factors contributing to its highway mortality.

Ordinarily the catbird builds a bulky nest of sticks, weeds, stems and a lining of rootlets and leaves in a clump of bushes, a low tree or a grape or ivy tangle, often near water. Bushy fence rows near woodlands are favorite nesting situations. The bluish green eggs number three to five and the incubation period is about 14 days.

Insects and other small invertebrates comprise about 44 per cent of the catbird's diet; ants, beetles, caterpillars and grasshoppers make up approximately three-fourths of this amount (McAtee, 1926, p. 78). Most of these insects are harmful to agriculture or forestry. The vegetarian proclivities of the bird are indicated by the considerable proportion of wild and cultivated fruit which it takes. Usually, however, the relative abundance of such uncultivated types as elderberries, blueberries, wild cherries, sumac and others, is sufficient to distract the bird's attention from such cultivated forms as cherries, strawberries, blackberries and raspberries to such a degree that little economic loss is sustained.

Eastern Brown Thrasher *Toxostoma rufum rufum* (Linnaeus)

Length 11.5 inches. Above reddish brown; below white or whitish heavily streaked with black or brownish except throat and middle of belly. The brown thrasher, sometimes erroneously called the "brown thrush," is a long, slender bird, larger than any of our true thrushes, with long tail, decurved bill and yellow eyes.

In the capital district the brown thrasher must be regarded as an uncommon summer resident. It arrives from the South in mid-April and seldom is it seen after mid-October.

The local scarcity of this fine songster is reflected in the rarity of its occurrence in Washington Park for which we have only five records. On May 17 and 18, 1938, a single individual, probably the same one, was seen on each occasion; on the former date our attention was first drawn to the bird as it sang loudly from the top of a tall elm tree near the shelter at the south end of the croquet ground. Evidently the thrasher remained in the park only for a day or two. A very shy and quiet individual was observed both in early morning and late afternoon on May 3, 1941, in the bushy tangles on a vacant lot immediately adjacent to the north side of the park. We had only fleeting glimpses of it as it sought concealment in low bushes; two days later a single bird was again seen in the same location, singing but not with the abandon that is sometimes displayed. One of two birds observed on May 5, 1942, was in low bushes near the west end of the lake, while the other was singing persistently and loudly about two blocks distant and in a back yard off Englewood Place.

The brown thrasher is another species that inhabits thickets and tangles. High, dry, shrubby undergrowth and bushy hillside pastures also are favorite nesting situations of this bird. It is not gregarious nor does it associate with other birds except as far as common wants bring them together.

The thrasher is more suspicious and wary than the catbird. Consequently it is less likely to occur about human habitations than that species. It is one of our finest songsters and imitators; its vocal efforts combine some of the qualities of its close relatives, the mockingbird, in their persistency and the catbird, in their fuller, richer and bolder tones. The brown thrasher is at its vocal best on sunny mornings in May and early June, when from a high tree top and with head tilted upward it utters its loud, clear medley. A harsh *"cuck, cuck, cuck"* is the usual alarm note.

This bird usually selects a bushy shrub, a small tree or a vine-covered tangle in which to build the nest of small twigs and coarse weed stalks. It sometimes adds a lining of softer material such as rootlets or grasses. The usual complement of eggs is four or five. About 14 days are required for incubation and the young remain in the nest for 10 to 12 days.

The thrasher finds a good deal of its food on the ground, particularly before the nesting season. Investigation of a vigorous scratching and shuffling of the dried leaves in a tangled thicket will often reveal one of these birds searching for food. This habit is responsible for the common name of the species.

According to McAtee (1926, p. 82), during the time that the brown thrasher is in this State about 63 per cent of its food is animal matter of which beetles constitute the major part; many of these or their larvae are inimical to horticulture and forestry. Other insects taken include caterpillars, grasshoppers, ants and true bugs. Approximately 36 per cent of the bird's food is made up of vegetable matter of which wild fruits, mast and corn, mostly waste, form the principal items.

Thrushes, Bluebirds Etc.: Family Turdidae

Eastern Robin* *Turdus migratorius migratorius* (Linnaeus)

Length 10 inches. Above dark slaty-gray; wings and tail fuscous, the head almost black; below reddish brown.

Every one knows this welcome harbinger of spring and common summer resident in the capital district. A few winter stragglers may be found locally but the spring movement becomes apparent early in March, and by mid-November the few robins that are left are likely to be found in wooded lowlands, the usual late seasonal retreat of the species.

In Washington Park the robin is one of the two species of native birds that we have noted on every formal field trip taken between March 24th and June 20th; only the bronzed grackle and the three introduced forms, the rock dove, starling and the English sparrow share this distinction. Our earliest spring record for a robin in the park is March 7, 1937. Other first seasonal records worthy of note are March 12, 1942, March 19, 1935 and March 17, 1938. Our latest autumn date is November 10, 1937.

From mid-March on to about April 25th the numbers of the bird steadily increase. Indeed, during the first three weeks of April the robin usually is one of the most abundant species in the park. Late in this same month, as the nesting time approaches, the numbers decrease somewhat due to the withdrawal of some of the birds into outlying districts.

One of the most striking ornithological sights that we have witnessed in Washington Park is the flocking of robins on cool, early, April mornings, perhaps following a southerly wind accompanied by rain and a rising thermometer. Under such conditions the scores of robins congregated in the park often blend their voices to produce a perfect bedlam of song. Sometimes the aggregation of birds will be halted there for several days when a sudden shift of wind to the northwest brings low temperatures. At this time the birds gather in little groups in sheltered places to avoid the chilling breezes. Then, as the weather moderates, their extraordinary numbers again become apparent as they run over the lawns, looking for earthworms or other food and now and again breaking into song. On April 22, 1933, the senior author walked the length of the park counting all the robins he saw between State street and a parallel line approximately a block south of it. He noted 24 individuals and estimated that more than

50 birds were within the park boundaries at the time. On April 21, 1939, 14 individuals were seen in one small, grassy plot near the northwest corner of the park. Indeed in most seasons from late March through the first week in April, the numbers of the robins equal, if they do not exceed, those of any of the other three species, the bronzed grackle, starling and English sparrow, which vie with it in relative abundance.

About April 1st or a little later the loose aggregations break up into pairs or sometimes threes, two males and a female or the reverse. Pairing having been consummated with, on occasions, a considerable amount of courtship activity such as feather display, strutting, vocalization and fighting, the robin turns to nest construction. Even as early as April 5th (1935) we have seen the birds carrying nest material. This activity, however, usually is at its height between April 10th and 25th. Both sexes take part in bringing the materials but the female does most of the shaping of the cuplike nest and the other detailed work upon it. The usual materials entering into the construction of nests in the park are grass blades held together by mud; finer grass blades are used for lining.

The nests are placed in a variety of situations and at varying heights above the ground. We have found them as low as six feet in a blue spruce. Most, however, seem to be constructed in elm trees at heights of 25 to 45 feet. Our earliest date for an apparently completed nest is April 25th (1935). We have known of at least six different nests in the park at one time and undoubtedly we could have discovered others had we made an intensive effort. In late April the birds become more quiet and less conspicuous as egg-laying and incubation occupy their attention. The bluish green eggs usually number four.

Throughout the months of May, June and July, mating, nest construction, incubation and rearing of young constitute the principal activities. Our earliest dates for young out of the nest are May 13, 1942, May 16, 1935 and May 18, 1938. Soon many young are out of the nests and their food calls to which the adults often respond in vigorous voice and sometimes with an insect or earthworm, mark the abundance of this welcome and successful species. No sooner is one brood of young able to shift for itself than the adults begin to prepare for a second; even a third brood is sometimes reared.

By mid-June the robin population of the park through addition of young, has again increased to its early spring level. The young leave the nest before they are able to fly well and require the care of the parents for some days before they are completely able to shift for themselves. The young have spotted breasts, which reveal the affinity of the species with the true thrushes. The first days out of the nest are a very precarious time in the life of young robins in the park. Stray cats, prowling dogs, inquisitive children and speeding motor cars are some of the disturbing and, at times, destructive factors with which the birds must contend. Frequently we have found the bodies of young robins crushed on the park roads. Important enemies of both young and adults in the park are the bronzed grackle and starling. Often we have seen these aggressive birds attack and torment robins without the slightest provocation.

Partial albino robins are frequently reported. On May 1, 1936, such a bird, apparently a female, was noted by us in Washington Park. The back was distinctly and abundantly streaked with white and the breast, belly and flanks also were well-marked with white.

Approximately 40 per cent of the food of the robin consists of animal food. The principal items are beetles, caterpillars, true bugs, two-winged and four-winged flies, grasshoppers, millipedes, sowbugs, earthworms and snails. About 60 per cent of the diet consists of vegetable matter, mostly wild fruits as wild cherries, raspberries, huckleberries, Virginia creeper berries and wild grapes. In addition, the bird feeds freely upon cultivated cherries and berries in season.

Of these foods, certain parasitic and predaceous four-winged flies (*Hymenoptera*), the predaceous beetles, earthworms, cherries and other cultivated fruits are useful to man. For the most part, however, the destructive qualities of the bird are mostly seasonal, while its neutral or beneficial characteristics are almost perennial. If we add to these its sentimental and esthetic value, we see that the robin may be rightfully accorded a warm spot in the hearts of all.

Wood Thrush* *Hylocichla mustelina* (Gmelin)

Length 8 inches. Above cinnamon-brown, distinctly brighter on head, olive-brown on tail; below white with large, round, black spots on breast and sides.

Probably the wood thrush is the best known of the thrushes proper. Ordinarily the first spring arrivals reach this territory late in April; seldom is it seen after October 1st. We have recorded it from Washington Park each season except 1935 and 1937. One or more individuals were seen on nine and 11 of 28 and 32 trips, respectively, in 1939 and 1940. Our best season for this species was in 1941, when we noted it on every one of the 20 trips taken between May 7th and June 27th. May 4, 1942 and May 4, 1944, are our earliest spring records; other first seasonal records range from this date to May 18th (1933). Our latest summer record is July 4th (1940) except in 1946 when one was seen on July 26th. The wood thrush ranks 31st on our frequency of occurrence table of birds seen in Washington Park. In our total of 1933-46 records we have noted this bird on 75 trips. In the following order, the thrushes, hermit, olive-backed, veery and gray-cheeked, are seen in diminishing number of dates during this study.

We have seen and heard the wood thrush oftener in the bushy back yards of adjacent private residences than in the park itself. The low bushes on the slope south of the lake afford the most satisfactory habitat for this bird in the park. For the most part, the comparatively formal and well-trimmed park shrubbery scarcely offers sufficient concealment to attract more than a few stragglers even at the height of the migration period.

The following notations by the senior author are descriptive of the frequency of the appearance and singing of this species in 1941, when it evidently nested in this urban area:

> "May 7. Two individuals. First seasonal record Thurlow terrace, back yard and street, singing vigorously.
>
> "May 15. Persistently present in back yard near Thurlow terrace and adjoining section of park. Singing all through the morning and again heard in the evening.
>
> "May 17. One bird sings volubly every morning during our visits, from the very top of a tall tree in a vacant lot between Englewood place and Thurlow terrace. This 'singing' tree stands out from those surrounding it and its slender spirelike top provides a perch from which all and sundry may *see* and *hear* the avian performer.
>
> "June 24. In the above same locality, today I noted an adult carrying small grayish lepidopterous larvae in its bill. Evidently young were reared and are now being fed. The adult was quite fearless and, as I remained motionless, the bird approached to within four feet of me.
>
> "June 27. L.C.S. saw the adult feeding young out of the nest and on the ground. Evidently a brood was successfully reared at the boundary of Washington Park."

This species was thought to be nesting again in the same neighborhood in 1946.

The wood thrush is partly arboreal and partly terrestrial in its habits; it prefers mixed woodlands, particularly those adjacent to the bogs or small streams. A moderate amount of undergrowth is essential. It is sometimes found in the vicinity of suitably landscaped human habitations. Unlike its relatives, the robin and the bluebird, it shows no tendency to associate in flocks. In some localities the wood thrush is known as the "swamp robin".

Chapman (1932, p. 413-14) thus characterizes the song of the wood thrush:

> "The songs of the wood and hermit thrushes are of the same character, but while the hermit is the more gifted performer, the wood thrush does not suffer by the comparison. His calm, restful song rings through the woods like a hymn of praise rising pure and clear from a thankful heart. It is a message of hope and good cheer in the morning, a benediction at the close of day. The flute-like opening notes are an invitation to his haunts; a call from Nature to yield ourselves to the ennobling influences of the forest."

This song has been written *"ee-o-lee"* which Doctor Chapman interprets as "Come-unto-me." It may be uttered from either a high or a low perch or from the ground.

The nest is usually placed five to 25 feet above the ground on a horizontal branch or in the crotch of a tree. Dried leaves, twigs and grass usually comprise the bulk of the structure, the bottom and sides of which are reinforced with mud. The usually three to five pale greenish blue eggs repose on a lining of fine grass.

McAtee (1926, p. 89) indicates that the 60 per cent of animal food which the wood thrush takes consists principally of beetles, caterpillars, two-winged and four-winged flies, true bugs, grasshoppers, millipedes and spiders. Many of these forms are injurious to trees and other vegetation of economic value to man. The approximately 40 per cent of this thrush's vegetable diet consists chiefly of wild fruits as wild cherries, mulberries and blueberries. Occasionally cultivated fruits are eaten but seldom in sufficient quantity to offset the bird's beneficial qualities in destroying noxious insects. Added to these are its musical, sentimental and esthetic attributes which all combine to render the wood thrush one of our most popular species.

Eastern Hermit Thrush*

Hylocichla guttata faxoni Bangs and Penard

Length 7 inches. Above olive-brown; tail distinctly reddish; below grayish white with a slight buffy tinge, white on belly; wedge-shaped black spots at sides of throat; breast with roundish spots.

FIGURE 35 A pair of white-breasted nuthatches reared a family of young in a nesting box placed in the maple tree to the left of the man walking. This is near north end of arched bridge. May 5, 1938

FIGURE 36 Nest box of white-breasted nuthatches in maple tree above ladder. The incubating pair of birds paid little attention to people walking on the sidewalk beneath them. May 6, 1938

FIGURE 37 Nest box pictured in figure 36

FIGURE 38 The upper hole is a new nest hole excavated by flickers eight feet up in an elm tree; they were evicted by starlings who then raised a family of young in this cavity. May 14, 1941

Of the thrushes proper, the hermit thrush is the first to appear in the capital district where it sometimes arrives in late March. Maximum numbers generally are not attained before the last week in April. Most of the birds move on to breed in the Canadian Zone of the Adirondacks and regions farther north but a few remain to nest locally. The southbound movement begins in September and extends into November.

In Washington Park the hermit thrush is of fairly common occurrence between April 15th and May 5th. Our earliest spring date is April 8, 1940, and the latest, May 18, 1940. In 1936 and 1942, we did not record the bird here until April 24th. This is our latest first seasonal date. During the entire time of this study we listed the hermit thrush on a total of 44 trips.

At the height of the migration period, the observer sometimes may see three or four individuals in the course of a two-hour trip in this bounded city area. Perhaps also he may hear one or two others singing in the adjoining back-yard thickets which are more often frequented by this bird than the more formal settings offered in the park. Here, as at Oneida lake and other places the hermit thrush fluctuates considerably in abundance. In Washington Park it occurred most frequently in 1940, when it was observed on eight of the 18 regular field trips taken between April 8th and May 18th. Again in 1941, between April 11th and May 5th, eight records were noted on the 18 trips.

Cool, damp forests are the favorite retreat of the hermit thrush. It is more shy than the wood thrush and even more highly terrestrial than that species. As the breeding season approaches the bird retreats largely to thicketed woodland where it is seldom seen but often heard. If the observer intrudes on his domain, the singer, with a flirt of his bright russet tail and a *"chuck"* of alarm, darts away to the low limb of a tree for furtive appraisal of the newcomer.

The song of the hermit thrush resembles that of the wood thrush but is characterized by a softer, flutelike quality and a more refined degree of modulation as well as a greater variety of notes. The regular series of full notes often is followed by several high-pitched, scarcely audible notes which, in turn, are succeeded by a flutelike series. Early morning and evening are the favorite hours for vocalization.

All the hermit thrush nests we have seen have been on the ground, usually in open spaces in dense woodlands. Dried grasses comprise the main structural material and finer grasses or pine needles, the lining. Four eggs comprise the usual clutch. In the Oneida Lake, New

York region, the senior author found eggs as late as July 20th and young in the nest as early as June 10th.

As with the other thrushes, beetles, caterpillars, true bugs, two-winged and four-winged flies, crickets and spiders constitute the bulk of the animal food. Its vegetable diet includes a large variety of wild fruits among which are sumac, Virginia creeper and blueberry.

Olive-backed Thrush* *Hylocichla ustulata swainsoni* (Tschudi)

Length about 7 inches. Above uniform olive brown; eye ring and lores buffy; below grayish white, strongly tinged with pale buffy, the breast with rounded black spots; middle of belly white.

In the Albany region the olive-backed thrush is a regular and moderately common transient in spring in May, and in autumn from mid-September to mid-October. In Washington Park the bird occurs regularly but usually rather sparingly. Our earliest spring date is April 27, 1938, and the latest, June 3, 1940. Another early first date was May 4, 1942, but usually the birds were not seen until the 9th or 10th of the month. In 1938, we had not only the early record of April 27th, but we observed this species on each of the eight regular early morning field trips taken between May 9th and 18th, while in 1940, one or more individuals were recorded on eight of 13 trips made from May 11th to June 3d. In the following vernal season the species was seen only twice. While one bird was listed on May 4, 1942, nine days later we recorded several and noted that there had been an obvious movement of olive-backed thrushes in the park during the past 24 hours. In all we listed this bird 40 times in our spring season studies, which is four less than for the hermit and considerably less than the 75 dates for the wood thrush. As evidence of this species passing through Washington Park in the fall, the record of two adults for September 15, 1943, is given.

During the period of the olive-back's likely occurrence in Washington Park, several individuals often may be seen in the course of a morning trip. They sometimes associate with veeries or other thrushes on the gravel paths in more secluded sections of the park where they permit the cautious observer to approach closely. The birds usually remain on or near the ground in low bushes. At this season of the year the species is quiet and retiring and seldom sings. Its low *"whit"* of alarm or caution, however, is frequently uttered. May (1939, p. 380) gives the following brief description of the song: "An ascending phrase, repeated at intervals without changing; suggests a veery song reversed."

In New York State the olive-backed thrush breeds in the higher forested sections of the Catskills and Adirondacks; possibly also it may nest in some of the elevated wooded sections in the capital district.

Northern Gray-cheeked Thrush*

Hylocichla minima minima (Lafresnaye)

Length about 7.5 inches. Above uniform olive-brown; eye ring not conspicuous; lores grayish, below with little or no buffy at sides of throat and grayish breast, the latter with roundish, black spots.

This thrush is to be rated as an uncommon transient in the Albany region in May and again during September. Owing to its similarity to the olive-backed thrush, from which it is to be distinguished principally by the lack of buffy on the breast and sides of throat, and by the grayish eye rings and cheeks, the gray-cheeked, or "Alice's thrush," sometimes doubtless is mistaken for that species. In Washington Park we have found the gray-cheeked thrush to be less common than any of the other thrushes and have recorded it on a total of only 14 dates. Our earliest spring date for the park is May 3, 1936, and our latest May 30, 1941. It appears to be commonest between May 10th and 20th.

We failed to see it in 1933, 1935 and 1942, but we have one record each for 1934, 1936, 1937 and 1941, and two each for 1938, 1940 and 1946. We observed the gray-cheeked thrush in 1939 on May 8th, 10th, 17th, 18th and 19th, and on the last date several individuals were seen as well as the two closely related olive-backed and wood thrushes. As this species appears to be so timid, even more so than the olive-backed thrush, perhaps that, too, partially accounts for our paucity of records for it.

During migration this shy bird is sometimes found on lawns and in shrubbery in the vicinity of human habitations as well as in wooded sections. The gray-cheeked thrush breeds in the Hudsonian Zone far north of the United States. It winters in northern South America. Studies of its food habits by the former United States Bureau of Biological Survey indicate that about three-fourths of the bird's food consists of animal matter. Many insects injurious to forest and other vegetation such as beetles and their larvae, caterpillars and grasshoppers are included in this category. Other animals taken are ants, bees, true bugs, spiders and millipedes. Wild fruits comprise the greater part of the vegetable matter eaten.

Veery* *Hylocichla fuscescens fuscescens* (Stephens)

Length about 7.5 inches. Above uniformly tawny or cinnamon brown; below, breast and sides of throat pale buff faintly spotted with small wedge-shaped brownish spots; belly white with sides slightly tinged with grayish.

The veery, or "Wilson's thrush," is the commonest of the three forms of thrushes which breed in the capital district. From late April to early October the observer is likely to find this bird in moist woodlands throughout the area.

In Washington Park we have recorded the veery less frequently and in smaller numbers than any of its congeners except the gray-cheeked; in fact we failed to note it there in 1933, 1935, 1937 and 1943. The greatest number of trips upon which it was recorded in any one season was that of 1940, when we observed it on seven of the ten early morning trips taken between May 14th and June 1st. Our earliest spring date for the park is April 28, 1939. Other early dates are May 4, 1944 and May 6, 1938. More often it makes its first appearance on about May 12th.

In all we recorded this thrush, which has such a distinct musical song, on 29 trips during this study. Usually we did not list it after the 20th of May but in two years, namely, 1938 and 1940, we have the late dates of May 31st and June 1st, respectively. It is of interest also that on May 18, 1938 and May 20 and 30, 1940, we observed not only this species but the gray-cheeked, olive-backed and wood thrushes.

While it is rather shy and retiring at all times the veery is in the open most during May. Concerted local migratory movements of this bird frequently may be observed, during which loose associations of some scores of individuals may be encountered in suitable habitats. A minor instance of flocking was evident in Washington Park on May 16, 1940, when we observed several birds in the course of the morning trip. As indicated above, our first record for that season was obtained two days earlier but only a single individual was then noted; a definite movement into the park had occurred during the following 48 hours.

As the breeding season approaches, the veery retires to outlying moist and boggy alder or other wooded thickets where it is more often heard than seen. The call note is a musical *"whee-o"* or *"teweu"* while, "His song is a weird ringing monotone of blended alto and soprano tones. Neither notes nor letters can tell one of its peculiar quality;

it has neither break nor pause, and seems to emanate from no one place. If you can imagine the syllables *'vee-r-r-hu'* repeated eight or nine times around a series of intertwining circles, the description may enable you to recognize the veery's song." (Chapman, 1932, p. 418.) May (1939, p. 383) adds that the song is "a descending liquid spiral repeated frequently without variation in phrasing." The period of most persistent and voluble song begins late in May, continues through June, and wanes perceptibly after mid-July. In traversing almost any local, wooded country district on a June evening, even the casual observer can not fail to be aroused by the vocal ability of this handsome thrush.

The nest of the veery is built on or close to the ground. Grass, leaves, rootlets and mud comprise the principal nest materials. The usual complement of eggs is four or five.

About 40 per cent of the food of this fine songster consists of vegetable substance of which McAtee (1926, p. 90) indicates the chief items are wild strawberries and blackberries, wild cherries, blueberries, elderberries, wild grapes and fruits of the sumac and dogwood. Of the animal food, he cites, "beetles, ants and other *Hymenoptera*, caterpillars, grasshoppers and spiders," as the principal forms taken.

Eastern Bluebird* *Sialia sialis sialis* (Linnaeus)

Length 7 inches. Male, above, including wings and tail, bright blue; throat, breast and sides reddish brown; belly white. Female, upper parts tinged with grayish; underparts pale reddish brown.

Familiar to almost everyone is this brightly colored harbinger of spring and summer throughout the capital district. Between early March, or even late February in mild seasons, and late October, the eastern bluebird is one of our characteristic roadside, orchard and open countryside birds. Occasionally winter stragglers are recorded from this area.

Washington Park is not one of the bluebird's strongholds in this region, for on only ten of our first 250 early morning field trips have we recorded the species in or flying over the park at an altitude low enough for positive identification. Our best season was 1934, when we noted the bluebird first on March 31st and later on April 3d and 19th and on May 1st. We have two records for 1933, March 31st and April 4th; and one record each for 1935 (March 29th), 1939 (April 21st), and 1940 (May 8th). On no trip have we observed more than a single individual in the park. Our 1940 record was afforded by three individuals flying low over the trees and uttering their characteristic soft warble which provides an acceptable and definitive field character. From all this it is evident, therefore, that the occurrence of the eastern bluebird in Washington Park is irregular and casual; the few individuals that do stop there remain for only a short time.

We believe that four major factors are largely responsible for the comparative lack of bluebirds in Washington Park. In the order of their importance they are: lack of open conditions; the paucity of suitable nesting sites in the form of hollow stubs and nest boxes; the presence of numbers of starlings, which vie with bluebirds for nest holes and boxes; and the characteristic fluctuation in number of the species from season to season.

The bluebird's song is a soft, low-pitched warble of four or five notes. It is sometimes written *"tu-ree-a-lee."* The wistful song of the female is somewhat abbreviated. A low call is often given during flight and when excited the bird utters a harsh *"chut."*

The bluebird mates early in the spring and the birds are often searching for nesting places in late April. Usually they build the nest in a hole in a tree, stump, fence post, or in a box provided by man. Although it can on occasions assert itself and display a degree of offensive belligerency and pugnacity, the bluebird has not sufficiently developed these tendencies to ward off such persistent interlopers as the English sparrow and the starling. The encroachment of these birds upon its domestic activities constitutes one of the bluebird's sorest trials. Circumstances permitting, nest construction is undertaken by both individuals of a pair; weed stalks and grasses with a lining of finer grasses constitute the bulk of the materials. The first clutch of eggs may be deposited in late April or early May. They are light blue in color and usually number four to six. A second or even a third set may be deposited. Despite this apparent fecundity, however, the numbers of the bluebird are so held in check by various types of "balancing agencies" that over a period of years the species does no more than hold its own.

Not long ago in Illinois, Musselman (1935, p. 117-25), in Canada, Krug (1941, p. 23-26), and in Tennessee, Lasky (1943, p. 39-43) attempted to encourage the presence of the bluebird in their respective localities by systematically erecting nesting boxes. Their efforts on the whole were well rewarded by an increase in the bluebird population.

From late June through the summer, adult bluebirds accompanied by young of the year often congregate along the edges of woodlands and in elderberry, blueberry and pin cherry thickets, there to feed upon the wild fruits and the ever-present insects. For some time after the young are able to fly well they are attended by the parents. The young are grayish with a tinge of blue in the wings, while the upper parts are streaked with whitish and the breast is spotted with brown. In this plumage they are often confused by the uninitiated with other species.

A little more than 65 per cent of the bluebird's food consists of animal matter of which grasshoppers, crickets, beetles, caterpillars and ants and their allies, together with true bugs make up the principal share. Wild fruits such as the elderberry, blackberry, raspberry, pin cherry and sumac berry comprise the major items of diet obtained from the plant world.

Its beauty of appearance, pleasing vocal ability, tendency to frequent the vicinity of human habitations, and beneficial economic tendencies all combine to promote the popular esteem generally accorded the bluebird. No doubt these factors were influential in its selection by popular vote of school children in 1927-28 as the state bird of New York.

Kinglets Etc.: Family Sylviidae

Eastern Golden-crowned Kinglet

Regulus satrapa satrapa Lichtenstein

Length 3.5 to 4.0 inches. Male, above olive-gray; feathers of wings and tail blackish with olive edging; center of crown reddish orange bordered by yellow and black; a white line over eye; below grayish white. Female, similar but center of crown bright yellow, bordered with black.

Next to the ruby-throated humming bird the golden-crowned kinglet is the smallest bird found in Washington Park. It is a fairly regular transient in the Albany region from late March to about May 1st and again on its southerly migration from early October through November. The bird is more or less regularly recorded here also in winter. This species, however, is far out-numbered in individuals by the abundant ruby-crowned kinglet in the park area.

In Washington Park we have seen the golden-crowned kinglet on 23 of our regular trips. Apparently, however, it does not remain long for our inclusive spring dates are March 24, 1938 to April 29, 1940. In the season of 1938, this kinglet was more prevalent than usual; it was recorded on six of the seven regular field trips taken between March 24th and April 16th; it was not seen after the latter date. The bird reached the height of its abundance between April 8th and 16th, up to which time it was more prevalent than the ruby-crowned kinglet. Several individuals, both males and females, were noted on April 8th, 12th, 14th and 16th.

In our experience the distribution of the golden-crowned in the park is often localized in the group of larches at the southwest corner of the lake. Here, on a bright early April morning several individuals may forgather to disport themselves among the lower branches of the trees in the warm sun and apparently to feed on the tiny larch buds as well as, probably, upon small insects. The tops of the larches north of the lake bridge are another favorite congregating place for this species.

The golden-crowned kinglet is an exceedingly active little bird; it flits so quickly from twig to twig that it is sometimes difficult to make out the field characters that distinguish it from the ruby-crowned kinglet. In vocal ability it lacks the volume and effusiveness of the latter species. Its squeaky notes resemble somewhat those of the brown creeper. The senior author has heard a song the first part of which resembles that of the ruby-crown while the last notes carried the qualities of those of the chickadee. It is particularly partial to cone-bearing trees as spruce, balsam, hemlock and larch. In New York State it nests only in the higher, evergreen-forested sections of the Adirondacks and Catskills.

Eastern Ruby-crowned Kinglet*

Regulus calendula calendula (Linnaeus)

Length about 4 inches. Male, above grayish olive, brighter on the rump; wings and tail brownish black, the feathers edged with olive; crown with a usually concealed patch of scarlet; below grayish white. Female, similar but lacking the scarlet crown patch. Both sexes have a whitish eye ring, while in the golden-crown there is a black line through the eye, with a white line both above and below it.

This sprightly little songster whose vocal ability belies its small size is a common transient throughout the capital district from about April 1st to mid-May and again in late September and October. In spring it usually arrives after the golden-crowned and in autumn it is seldom recorded as late as that species. It is of more general distribution than the golden-crown and, during migration at least, does not limit itself to any particular type of habitat although the shrubbery in both cultivated and wild situations is a favorite retreat.

In Washington Park we have found the ruby-crown persistently present and common every vernal season. Our earliest spring date is

FIGURE 39 Young flickers, age about 15 to 18 days, like these are raised in the park

FIGURE 40 Young flickers, 20 to 22 days old

FIGURE 41 A flicker about 26 days old

FIGURE 42 A number of Austrian pines adorn various sections of the park. The yellow-bellied sapsucker visits them frequently and its drillings result in disfiguration through excessive flowing of sap and tumescences on the bark. May 4, 1938

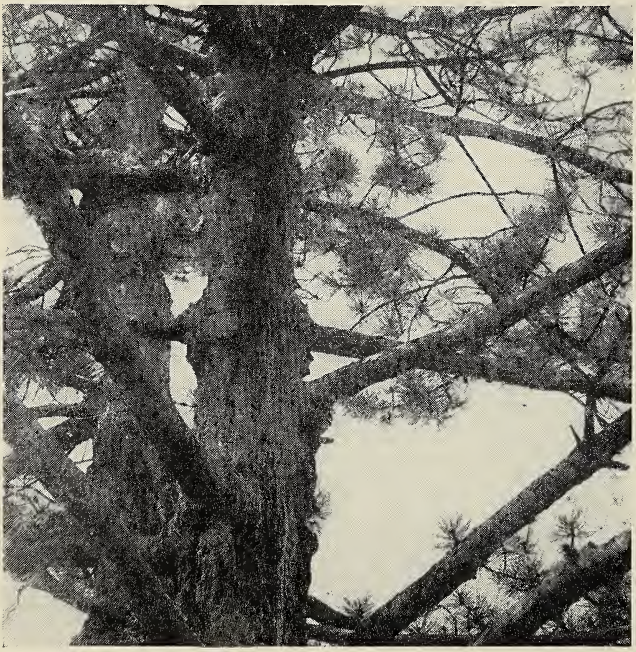

FIGURE 43 Drillings of the yellow-bellied sapsucker on the Austrian pine shown in figure 42. Note accumulation of gum that has issued from the wounds as sap. April 21, 1938

April 1, 1946; our latest, May 19, 1935, 1940 and 1941. There is a gradual increase in numbers from an individual or two in early April until, by the addition of incoming migrants, the ruby-crown becomes one of the most populous species for a few days (April 25th to 30th), then it decreases gradually until by May 15th only a few stragglers remain.

In relative frequency of occurrence, the ruby-crowned kinglet ranks 14th in our list of park birds; it has been observed on 133 of our first 250 regular early morning trips of which 195 were taken between April 10th and May 20th. Forty more observation dates, one of which was for September 29, 1943, were made for the bird in the next four years. On April 24, 1936, in a trip lasting 90 minutes, we saw more than 50 of these kinglets; on May 8, 1935, more than 20 were observed in a similar length of time. In 1941, we recorded this species on 23 consecutive trips taken between April 11th and May 12th, while in the vernal seasons of 1937, 1938, 1939, 1940 and 1942, we have listed it 15, 16, 18, 13 and 16 times, respectively.

In spring the favorite habitats of the ruby-crown are low-lying thickets bordering streams or ponds and the margins of woodlands. Low, more or less open woods are favored by them in autumn. While they are not strictly gregarious, small, loose groups often occur in the shrubbery along swampy streams. One of the favorite retreats of this kinglet in Washington Park is the clump of "coral bushes" (Japanese quince) on the hillock on the north side of the lake east of the bridge. Here these restless, energetic little birds congregate to feed and otherwise busy themselves in efforts which, to the human observer at least, have no fruitful point. In feeding they often hover after the manner of a humming bird.

It is during these spring gatherings that the remarkable vocal ability of the ruby-crowned kinglet attains its maximum richness and complexity. The ordinary song begins as a slow, high-pitched warble, changes suddenly to a lower-pitched complicated warble and closes with several high notes. This mellow, warbling song is one of our sweetest bird voices; its volume and carrying capacity suggest a vocalist of a size larger than this diminutive kinglet. On some bright late April mornings the shrubbery fairly resounds with the effusive warblings of the males as they burst into ecstatic song, each apparently trying to outdo the others. It is at these times also that the males put on the best display of their brilliant red crown patches, covering and uncovering them at will.

The ruby-crowned kinglet breeds in the coniferous forests of the Canadian and Hudsonian Zones where its (often) semi-pensile nest of mosses and lichens is well-concealed. Five to nine white eggs comprise the clutch.

According to the limited amount of information available concerning the food of the ruby-crown, its diet consists principally of ants and other small four-winged flies (*Hymenoptera*), small bugs such as plant lice, scale insects and leaf-hoppers, and small beetles, and two-winged flies (*Diptera*).

So much of bird energy, song, beauty and utility is combined in the ruby-crowned kinglet that no one can fail to have a warm spot in his heart for this diminutive and hardy bird.

Waxwings: Family Bombycillidae

Cedar Waxwing* *Bombycilla cedrorum* Vieillot

Length 7.25 inches. Above grayish brown, the feathers with a silky texture; head with a conspicuous erectile crest; below grayish brown, yellowish on belly; forehead, chin and line through the eye black; tail with a uniform terminal yellow band; tips of secondaries often with small, flattened, scarlet, waxlike appendages.

In the Albany area the cedar waxwing is a common summer resident from mid-May through October; occasionally it is recorded in winter. Transients are likely to appear about mid-March.

For Washington Park we have recorded the species in only four seasons. In 1933, we observed it on four of the eight early morning field trips taken between March 31st and May 8th; in 1937, we have eight records for 11 trips made between April 13th and May 1st; and in 1938, we noted the species on nine of the 18 trips taken between April 19th and May 14th; while in 1941, groups of five or six were seen feeding on buds in the crab-apple trees located near State street on May 14th, 15th and 16th. For each of the first three seasons cited the first date given is the one on which the waxwing was first observed, the second, the one on which it was last noted in the park. Probably the species was present in the neighborhood of the park on intermediate dates or perhaps even in the park either immediately before or after our field trips. For, as is well known, this bird is more or less of a vagrant and likely to appear in or disappear from such a circumscribed area within a surprisingly short space of time.

The gregarious proclivities of the cedar waxwing are indicated by the fact that on every occasion that we have noted the bird in Washington Park it has occurred in groups of from three to about 50 individuals. The usual flock consisted of from 10 to 20 birds. Frequently the larger flocks break up temporarily into two or three or more, smaller ones; a few single birds, even, may become temporarily detached from the main flock. The observer, therefore, should be on the alert for a group of individuals should he come upon one or two apparently unattached birds.

In the park we have most frequently observed the waxwing in tall trees, principally maple, elm and ash. The maples on the north side of the lake, the silver-leaved poplars on the hillside not far away and the elms and ashes near Sprague place are places one would be likely to find it. The birds are fond of the buds of these trees and often so intent are they on feeding that they will permit the observer a surprisingly close approach. Frequently attention is first drawn to a flock of these birds by the high-pitched, lisping trill *"tse-tse-tse,"* their only vocalization.

As spring progresses the waxwings increase in number locally and become more generally dispersed in the outlying sections. Flocking persists and remarkably close order and coordination of flight is maintained in many of their aerial group movements. Often the members of a flock will remain motionless for a time in a tree as they assume a peculiarly erect posture and then elevate and lower the elongated feathers of the crest. Eventually they may begin to feed and move about, or with a chorus of lisps arise and in swift, concerted flight take up a new location.

During the breeding season in particular, adult waxwings often give interesting evidences of affection toward one another, as mutual touching of the tips of the bills, and preening and feeding each other. Courtship antics include also various other demonstrations of apparent admiration and affection on the part of the paired birds.

The cedar waxwing seldom nests before mid-June; usually the time is later, even as late as September. High hardwoods and the vicinity of orchards, roadsides and villages are favorite situations. Usually the nest is a crude bulky structure, its composition depending largely upon the kind of material that is readily obtainable. Such items as twigs, weed stems, bark, plant fibers and rootlets commonly provide the basic materials; a lining of horsehair, wool or plant down also is usually incorporated. About our homes such domestic items as rags, paper and string are freely used. Four or five eggs make up the usual clutch.

Approximately 85 per cent of the cedar waxwing's food consists of vegetable matter; wild cherries, uncultivated strawberries, cedar berries, blueberries and June berries are the principal ones taken; among cultivated plants the flowers and fruits of certain trees, particularly cherries, are highly relished; its fondness for the latter fruit is accountable for one of its common names, "cherry bird." Among the food items of animal origin, beetles predominate; some of these are inimical to horticulture and agricultural pursuits. Other insects taken include various species of true bugs, caterpillars, sawfly larvae, Mayflies, stoneflies and dragonflies.

Whatever the cedar waxwing may lack in desirable qualities from a strictly economic standpoint, its pleasing appearance and sociable, yet composed, manner have a certain compensatory esthetic value.

Starlings: Family Sturnidae

Common Starling *Sturnus vulgaris vulgaris* Linnaeus

Length 8 inches. Adults in summer, shining purplish black or greenish black, feathers of upper parts tipped with pale buff; tail short; bill yellow. Adults in winter have the plumage speckled above with buff, and below with white; bill blackish brown.

From the sixty starlings released in Central Park, New York City in April 1890, and an additional forty freed there in 1891, have come the millions of these birds which inhabit this continent from New Brunswick to the Gulf of Mexico and from Nova Scotia to far Washington. The spread of this trim-appearing, hardy, adaptable and prolific introduced bird, the sole representative of its family in North America, has been gradual yet phenomenal.

Concerning the first occurrence of the starling in the Albany region we quote from an informal note which the senior author discovered in the Zoological files of the New York State Museum, which was written by Dr Willard G. Van Name, formerly Zoologist at the Museum.

> "First starlings seen about Albany, a flock of five or six near the canal between North Albany and Brookside, February 26, 1911. They stayed around in that vicinity until some time in April at least, but none were seen about the city except a single bird on the steeple of St. Peters Church in the spring of 1911. None were noted at North Albany in the summer or fall of 1911. On March 11, 1912, three birds were seen near the canal at North Albany. None seen since then (date of writing Feb. 25, 1913). Flock of six seen out Delaware avenue, February 18, 1914."

The late Professor Barnard S. Bronson first recorded seeing four starlings near Troy, N. Y. on March 3, 1916 and J. T. Nichols (1937) states that the starling did not reach Albany until 1916. It would appear from Doctor Van Name's observations that the species was present sparingly some five years earlier. At the present time it is one of the most abundant birds in the region during the entire year and in Washington Park it has become one of the commonest nesting species. Along with the pigeon and English sparrow it shares the distinction of having been seen on every observation trip that we have made there.

As early as March 29th in 1935, a starling was observed carrying nesting material and by April 5th, several nests were under construction in hollow limbs of maple trees; on another early date of March 30, 1938, we noted an individual gathering supplies for its nest. All through April these birds may be seen transporting sticks, grass, or paper; usually nests are completed and incubation well along by the end of this month as explained in our field note for April 28, 1941: "The birds are comparatively quiet now and are not so much in evidence; egg-laying and incubation are the principal activities. Only one carrying nest materials this morning."

On May 4, 1936 and May 8, 1933, and in other years on early dates of this month, we noticed the adults transporting food to the young; the calls of these juveniles demanding food could be heard as the parent appeared at the entrance of its domicile. Shortly after the middle of May the young climb to the opening and peer out at the world, now seeming mature enough to leave on their initial flight; by the end of the month and in early June many young are seen following the adult about on the ground and their raucous food calls are heard on all sides; quite a number of these juvenals are able to shift for themselves while others are still attended by parents. Soon some of the adults are again seen picking up nesting materials, preparing for a second brood; this we noticed on June 14, 1940. On the same date in 1941, we saw "many young birds together without the adults on a lawn adjoining the park. There were 15 in one location while similar groups were observed in other places. Few adults are seen now; they are evidently busy laying and incubating second brood eggs."

The starlings do not often spend much time or labor in excavating for their nests but may use crevices under eaves and cornices of buildings; usually they occupy hollow trees or usurp the nesting holes of native species in the park, frequently using old or new woodpecker nests. Both sexes are quite contentious and antagonistic in their relations with other species during this period and particularly when the nesting site is questioned or disputed. Once the new home is selected seldom can any other bird rout them, but often they may drive different species from their hard-earned domiciles, as evidenced by a late nesting record of May 12, 1941: "A pair of starlings has evicted a pair of flickers from a nest hole just excavated by the latter in the partially hollow trunk of an elm tree just south of the fountain shelter. This again illustrates the belligerent tendencies to usurp the domiciles of other birds. The starlings are entering and leaving the excavation at frequent intervals and apparently are constructing a nest therein."

We have found their nests in most parts of this 90-acre recreational tract of ground and at various heights depending upon the available sites. They have been found in maples, at one place 15 feet from the ground near the north side of the lake and in another in the tops of the tall trees in the northeast corner of the park. Others were in the high poplars in the northwest sector, where they also were in elm stubs 40 feet up. Still others were in tall elms near the center of the park and in small elms near State street, while many more were in different kinds of trees scattered throughout the park. Each nest contains four to six eggs which are a little paler in color than, but equal in size to, those of the robin.

Their imitative vocal ability is quite evident during mating and nest building periods when they utter a variety of calls and whistles. We have heard them imitate with a certain degree of accuracy the following birds: bob-white, killdeer, flicker, wood pewee, blue jay, bluebird, warbling vireo, house sparrow, meadowlark, redwing, Baltimore oriole, bronzed grackle, rose-breasted grosbeak and field sparrow. Hence a word of caution to amateurs may not be out of place as to identifying birds by ear in the park; before recording a bird, be sure that it is not a starling giving the song or call of some other species. They are noisy birds and deliver frequent harsh sounds. These queer calls or songs are often accompanied by a flapping of the wings.

One way to differentiate the two very common birds of black plumage is to call the bronzed grackle the long-tailed blackbird and the starling the short-tailed blackbird; also to notice that the latter has long, pointed wings overlapping the tail. Also, as noted above, the starling in winter is distinguished by its heavily speckled plumage and its black bill, while in spring the general plumage of this bird is metallic purplish or greenish and the bill is yellow. The young are brownish in color.

Their peculiar jerky walk when on the ground is characteristic and as they fly, an observer may often see a group rise in a concerted movement, flying to a tree top or roost, usually keeping up a loud prattle as they alight. This is illustrated by our notes for November 1, 1939: "During late summer and early fall large numbers of starlings, both young and adult, congregated in the southwest corner of Washington Park where they roosted in trees. As they assembled they kept up an incessant low chatter."

Occasionally these birds are struck and either killed or injured by motorcars when they feed on or fly over the driveways; on June 15, 1938, we found a dead starling on the pavement, which evidently was the victim of an automobile.

Every year during this study different groups were seen in early morning hours in winter or early spring flying into the park. These birds may have been some of the hundreds that roost during winter nights in or on crevices and cornices of the State Education Building or other large buildings downtown as they have been seen coming from that direction.

While starlings have increased in numbers in Washington Park during these past years and are considered more or less of a pest, they may also be termed a beneficial species as they are known to consume vast quantities of noxious insects.

Vireos: Family Vireonidae

Northern White-eyed Vireo

Vireo griseus noveboracensis (Gmelin)

Length about 5 inches. Above olive-green, line from nostril to and around the eye, yellow; two whitish wing bars; iris white; below whitish, sides yellowish.

This very rare visitor was recorded by us in three years of our Washington Park study. Two were heard singing in a tall elm tree on May 6, 1933, and a fairly good view was had of one of these individuals. Then one bird was listed on each of the mornings of May 12, 1935 and May 17, 1938. The white-eyed vireo is similar in appearance to other vireos but has an unusual call note and a different song including imitations of the notes of other birds.

A. A. Cruickshank (1942, p. 363-64) reports this species as arriving usually late in April or early in May on Long Island where it nests. The favorite habitats are lowland thickets near forest margins, so we can not expect to see this vireo often in Washington Park; in fact there are very few records for the white-eyed vireo in Albany county. It is considered a rarity in central upstate New York. Eaton (1914, p. 376) records that one observer noted it as a summer resident at Troy, New York, a number of years ago.

Yellow-throated Vireo* *Vireo flavifrons* Vieillot

Length 5.5 inches. Above olive-green, grayish on rump; two distinct white wing bars; eye-ring yellow; below, throat and breast bright yellow; belly white.

Although some of the vireos are difficult to identify satisfactorily in the field, the yellow-throated vireo is, on the contrary, easily distinguishable from its congeners not only by the color characters cited but also by its deliberately uttered, deep contralto notes. In the capital district it is a moderately common summer resident, arriving early in May and remaining until late September, by which time most individuals have left for the winter in Mexico and Central America.

In Washington Park we have observed the yellow-throated vireo every season except 1934. Our earliest spring record is May 1, 1940 and 1942; other first spring dates are May 4, 1938, May 10, 1936 and 1937, May 11, 1939 and May 16, 1933 and 1935. We have noted it on 75 of the 144 regular morning field trips taken between May 1 and June 20, 1933 to 1942. According to our observations the yellow-throat was most prevalent in 1938, when we recorded it on 13 of the 17 trips taken between May 4th and June 20th, inclusive; in 1941 and 1942, we observed the species on 13 of the 21 and 18 respective trips taken between May 1st and June 14th. Of all the vireos recorded from the park the yellow-throated vireo ranks second in frequency of occurrence. It is far surpassed in actual numbers, however, by the warbling vireo and possibly also by the red-eyed vireo, though in the course of a morning trip about mid-May several individuals of both species are likely to be encountered.

During May and again later in the season the yellow-throated vireo often sings from the lower branches of shade and orchard trees. The song is uttered in a characteristic jerky tempo common to all the vireos and is made up of three portions, each of which is uttered rapidly, often with a pronounced pause between them. Chapman (1932, p. 433) interprets the song thus: "See me; I'm here; where are you?" He also says: "If the red-eyed vireo is a soprano, the yellow-throated is a contralto." On favorable mornings in mid-May this is one of the prominent bird voices in Washington Park. Shortly thereafter the numbers of the birds diminish as many move into the outlying orchards, roadside maples, or hickory or other hardwood trees near the edge of a woods to nest. The occurrence of the bird within the park as late as June 20th suggests that it may nest there but we have no definite evidence on that point.

The nest is composed of plant fibers, grass and strips of bark and is suspended in a fork at a height of 15 to 30 feet above the ground; its exterior is decorated with lichens and spider's silk. The usual complement of eggs is four or five.

The autumnal renewal of song in this species is vigorous though the effort at each singing is short-lived and somewhat abbreviated if we may judge from the bird we heard singing at 8.30 a.m., E.W.T. on September 1 and 2, 1942. Again in the fall of 1943, on September 15th and 22d, and October 6th, the bird was seen and heard.

McAtee (1926, p. 73-74) stated that more than 95 per cent of the animal food of the yellow-throated vireo in New York consists of insects that are injurious to trees. Caterpillars, moths, cicadas and other true bugs, leaf chafers, wood borers, twig girdlers, and other injurious forms are included in the lot. Spiders also are freely taken. A slight amount of vegetable substance, principally wild fruits, is eaten. Esthetically, vocally and economically the yellow-throated vireo is a desirable bird.

Blue-headed Vireo* *Vireo solitarius solitarius* (Wilson)

Length 5.5 inches. Above olive-green; head bluish gray; eye ring white; two distinct wing bars; below white, the sides pale greenish yellow.

On the average, the blue-headed or "solitary vireo" is the first representative of its family to arrive in the spring. In the capital district it is a moderately common transient between late April and late May and again from September through October. Probably also the bird may nest here sparingly but we have no concrete evidence to bear out this supposition.

The local status of this vireo varies considerably from season to season, particularly in Washington Park where we did not record it until 1936; that season we saw the bird on seven of the 11 early morning trips taken between April 27th and May 11th. Similarly, in 1937, we noted this species on three of four trips between May 12th and 16th; in 1938, on eight of 16 trips between April 19th and May 12th; in 1939, on 10 of 17 trips between April 26th and May 18th; and in 1940, on five of 10 trips between May 8th and May 18th. In 1941, this species was observed on all except one of the 19 trips taken between April 19th and May 14th, but in 1942, we had only a few records, namely five of 10 trips between April 24th and May 6th. It will be noted that in the seasons 1938 and 1941 our earliest date was April 19th. Usually first arrivals reach this territory five to six days later.

May 18th (1939 and 1940) and May 20th (1946) are our latest listings except a fall date of September 29, 1943.

With reference to occurrence frequency, these figures relegate the blue-headed to fourth place among vireos. Likewise, in number this species ranks below the warbling, yellow-throated and red-eyed vireos. Frequently only a single solitary was noted on an entire morning trip though occasionally at the height of the season two or three were recorded. On several of our 1938 trips, however, three or four or more individuals were seen.

This vireo usually occurs in the more secluded portions of wooded areas. Its habit of remaining well-hidden in the higher foliage of trees or in dense, well-shaded, lower branches renders it difficult of detection. It is inclined to be more restrained in its activities than our other common vireos. Often in the subdued light of heavily-canopied wooded sections the bird will permit the quiet observer a close view while it is singing or feeding. In mid-May the wooded hillock north of the park lake is a good spot to view this bird. By mid-May, or shortly thereafter, the solitary has moved into higher, and for the most part, more northerly wooded sections.

While the song of the blue-headed vireo is characterized by a certain degree of harshness and disconnected phrasing, its musical qualities are rather more pleasing than those of our other vireos. This song is less monotonous than that of the others; in pitch it simulates that of the red-eyed vireo, in rhythm it approaches that of the yellow-throated vireo. While the solitary is rather less persistent than the red-eyed vireo in its vocal efforts, it carries them through July and even into August.

It is interesting to note that all four of these common vireos namely, warbling, yellow-throated, red-eyed and blue-headed, were heard or seen in Washington Park on the following six mornings: May 11, 1936, May 13, 15, 1937, May 4, 9, 1938, and May 18, 1939.

Most of the food of the blue-headed vireo consists of insects of which the larger share is harmful from the standpoint of man. Caterpillars, true bugs, beetles, sawflies and ants are among the commoner forms taken. Many of these are pests of farm or forest. About one-tenth of the bird's food is obtained from the vegetable kingdom, principally in the way of wild fruits.

The pleasing appearance, vigorous song and beneficial economic qualities combine to render the blue-headed vireo one of our entirely acceptable bird species.

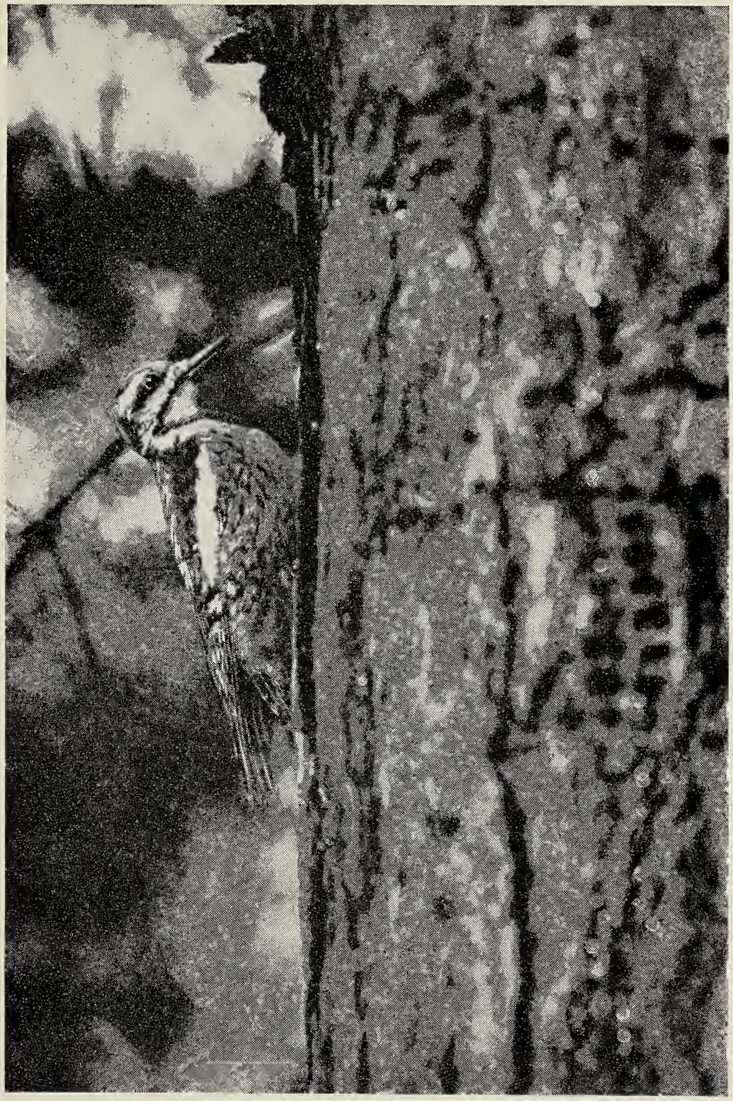

FIGURE 44 The male yellow-bellied sapsucker is one of the spring visitors in the park. Photo by Guy Bailey

FIGURE 45 Work of yellow-bellied sapsucker on the trunk of a large ash tree. The elongate white areas below the drillings are caused by the flowing sap which has fermented in the warm weather, thus giving it a frothy appearance. May 4, 1938

Red-eyed Vireo* *Vireo olivaceus* (Linnaeus)

Length 6.25 inches. Above olive-green; crown gray, bordered on each side by black; a white line over the eye; iris red; no wing bars; below white.

Among the local members of the family Vireonidae the red-eyed vireo is the most generally distributed and the most persistent vocalist in the Albany region from mid-May through late September. Yet the red-eyed vireo is surpassed in both numbers and frequency of occurrence in Washington Park by both the warbling and yellow-throated vireos. Our earliest spring record is April 30, 1938, which also is a very early seasonal record for the region. It will be recalled that the spring of 1938 was unusually early and a number of unseasonably warm, even hot days succeeded one another. At least in partial consequence of these meteorological conditions many kinds of birds, including the red-eyed vireo, put in their local appearance well in advance of the customary date. Our other first seasonal dates for this bird in Washington Park vary from May 8, 1933, to May 16, 1935 and 1940. During the latter season it was noted on 12 of the 13 regular trips taken between May 16th and June 14th. Our records show that this vireo was recorded on 61 of the 137 regular morning trips made from April 30 to June 17, 1933 to 1942. Other later June records also are available. While we have no positive evidence of its nesting in the park we suspect that it may do so.

The red-eyed vireo is an inhabitant of hardwoods and mixed growths, aspen thickets and, to a lesser extent, the shade trees of our city streets. Woodlands with an undergrowth of slender saplings from six to 15 feet high are favorite haunts. It shows a predilection not for the highest tree tops but rather for the lower shaded undergrowth. On account of the almost complete lack of such situations in Washington Park this bird is compelled, for the most part, to remain in the higher trees.

The clear, musical, high-pitched song is uttered with monotonous persistence through the summer and even on the hottest days. The sobriquets "preacher" and "preacher-bird," by which this vireo is known in some quarters, have been given it by reason of this persistent vocalization. Food searching and singing are often indulged in at the same time. Sometimes the singer pours forth his lay from a dense growth of bushes and saplings in the midst of, or at the margin of, a heavy woodland.

A. A. Saunders (1923, p. 298-99) describes the song, in part, as follows: "It is made up of short phrases of one to five notes with a short pause after each. These phrases vary greatly, and a little careful observation will show that each individual bird has 25 to 30 different ones, repeating certain of them frequently . . ." Some writers in attempting to describe the repetitious song put into it the words "see me; up here; in the tree." During the nesting period the bird often utters a complaining nasal *"whang."*

Low-lying deciduous woods provide suitable breeding situations. Nesting occurs from late May through June. The basket-shaped nest is usually suspended from the fork of a sapling five to ten feet from the ground. Plant fibers, bark and fine rootlets are woven into a firm basic structure, the inside of which is lined with finer rootlets, while the outside is decorated with bits of birch bark, spiders' web and other whitish materials. Three or four eggs comprise the usual clutch. The cowbird often thrusts its presence into the home life of the red-eyed vireo and it is not unusual to find a nesting pair of these vireos acting as foster parents for one or more young cowbirds, usually to the destruction of their own offspring.

The diet of the red-eyed vireo consists principally of caterpillars, moths, beetles, two-winged and four-winged flies and true bugs. Some of these forms are beneficial from man's viewpoint in that they prey upon or parasitize other insects, most of which are harmful. A small amount of wild fruit also is eaten by this vireo. In all the red-eyed vireo is a desirable bird citizen.

Philadelphia Vireo *Vireo philadelphicus* (Cassin)

Length 4.75 inches. Above olive-green; a whitish line over eye; no wing bars; below pale greenish yellow.

This very rare transient visitor in the Albany region was listed by us on only one occasion in Washington Park, namely on May 9, 1939.

Judd (1907, p. 66) gives one record for the Philadelphia vireo in Albany county. The senior author commented that possibly the species is commoner than our records indicated.

In our identification we noted the absence of wing bars and the yellowish underparts. While this small bird sings somewhat like the red-eyed vireo, it looks more like the warbling vireo which has paler underparts.

Eastern Warbling Vireo *Vireo gilvus gilvus* (Vieillot)

Length 5.5 inches. Above grayish olive-green; a whitish line over the eye; no wing bars; below white with a faint yellowish tinge. The indistinctly striped head, white underparts, lack of wing bars and its characteristic warble, are good field characters.

This songster, which gives such a firm, yet musical and continuous warble, is the commonest representative of the family in Washington Park. It has been recorded on 125 of our 149 regular early morning spring trips taken between April 28th and June 17th, and ranks 15th on our frequency of occurrence list compiled for the first ten years of this study. Usually the warbling vireo arrives in the Albany area some time during the first week of May; all except two of our first park records were noted before May 10th. On April 28, 1938, several individuals were noticed and from then on their numbers increased somewhat until about the last week in May; this is typical of their numerical occurrence in other years.

We recorded this vireo on each of 21 trips taken between the inclusive dates of April 28th and June 20th in 1938, and May 6th and June 14th in 1940.

The warbling vireo is more often heard than seen as it stays among the leaves in the tops of the trees. The male is a persistent singer and repeats his beautiful musical melody over and over during the day as he flies to various kinds of trees in different sections of the park.

In the morning chorus of bird songs heard on May 9, 1938, we reported that the voice of this species was dominant in the park. Five days later the warbling and yellow-throated vireos were the two commonest members of the family either heard or seen. By May 31, 1938, a reduction in numbers and in frequency of song was noticed, until probably only three or four nesting pairs remained within the boundaries of this city area.

Only occasionally during a hot summer day, as on June 13, 1942, did we hear the plaintive melody of this vireo. It was not heard on an all-day park trip on July 26, 1942, when 12 other birds were recorded. In the fall only one individual was heard singing weakly and sparingly on September 29, 1943.

The warbling vireo is rightly named for it delivers a connected rapid warble. The song, which is somewhat similar to that of the purple finch, starts on a low note, then partially ascends the scale and after a slight accent on the highest note, it again goes down and starts all over again. The bird repeats this about six times and ends abruptly on a high note. This song is so distinctive and different from that of the other vireos that it can be easily learned. Ralph Hoffman estimates that at the height of the nesting season, this vireo repeats the warbled song over and over several thousand times in a day.

Before the leaves are out in March and April, its last year's nests or fragments of them, are plainly visible. In 1940, we found two nests of this species in the tall elms on the high mound in the central part of the park.

Wood Warblers: Family Parulidae

Black and White Warbler* *Mniotilta varia* (Linnaeus)

Length 5.25 inches. Male, streaked with black and white above and below, middle of belly white. Female, similar but less streaked below, sides more or less washed with brownish.

This well-known and easily identified warbler is a fairly common migrant and probably breeds sparingly in the Albany area. It is one of the first of its family to arrive in spring and may be expected any time after April 20th. Some are present through September.

Although we have never found the black and white warbler common in Washington Park, we have noted it there every season except that of 1933. Our earliest spring date is April 27, 1934. Other first spring dates for the park vary from April 30, 1936 to May 13, 1942, while May 18, 1938, is our latest spring date. The bird keeps well to the deciduous trees and the larches and might be easily overlooked were it not for its weak, high-pitched, oft-repeated and characteristic *"wee-see"* note.

In the spring movement the males usually precede the females by some days. While this warbler is not gregarious, the observer may sometimes come upon a loose group of four or five individuals climbing about over the trunks and limbs of trees, busily looking for food and intermittently calling to one another.

The bird has been reported on 26 morning trips in the first ten years of this study, which is the same number as for the eastern yellow warbler and American redstart. These birds are numbered 48, 49 and 50 on our frequency of occurrence schedule as alphabetically listed.

The black and white warbler creeps about in a manner similar to, but more rapid than, that of the white-breasted nuthatch. As it searches for food on the bark of a tree, the bird's plumage blends well with its surroundings and makes it quite inconspicuous. Sometimes it clings to small branches as it stretches its body to peer along the lower side of a leaf or to inspect a deep crevice or cranny where small insects may be hiding. The bird apparently climbs up or down or even sideways with about equal facility.

In summer this warbler for the most part frequents dense mixed woodlands. The nest usually rests in a depression in the ground partly protected by an old log or stump. Grasses, rootlets and moss comprise the bulk of the nest material to which is added a lining of softer substances. The four or five whitish eggs are spotted with brown.

This active warbler must be numbered among the forester's friends for it feeds principally upon wood-inhabiting beetles, caterpillars and ants, together with two-winged flies, moths, true bugs and a few four-winged flies. Spiders and daddy longlegs also are eaten.

Tennessee Warbler* *Vermivora peregrina* (Wilson)

Length 4.5-5 inches. Male, above olive-green; crown and nape bluish gray; a distinct white line over the eye; no wing bars; below white. Female similar, yellowish below.

Once the spirited song of this loud-voiced warbler is learned, the species is much oftener located by ear than by eye. In general, the Tennessee warbler is considered an uncommon transient in the Albany area throughout May and again in September. Occasionally, however, as for example in the season of 1938, the local prevalence of the bird is noteworthy. That season it was recorded on six of the 12 early morning trips taken in Washington Park, May 4th to 17th, inclusive.

The many tall elms in Washington Park and the silver-leaved poplars on the knoll near Thurlow terrace offer local inducements for the Tennessee warbler to tarry during its northerly movement. It usually remains near the tops of these trees; this habit, together with its persistent activity and plumage colors which blend so harmoniously into the leafy background, render it difficult to observe except for fleeting moments. We did not record the Tennessee in the park in 1933, 1936 or 1941. Our first seasonal records vary from May 4, 1938 to May 19, 1935. In all we listed this warbler on 16 trips between 1933 and 1942. The junior author had additional records of May 13th, 14th, and 20th in 1946.

This is one of the warblers that shows marked waves of migration. If the observer is not fortunate enough to have been in the field during one of these waves, he may miss the species altogether or at most note only a few stragglers. A conspicuous movement occurred in Washington Park on the morning of May 13, 1938. At that time the loud, energetic song of the Tennessee and the trill of pine warblers were two of the most conspicuous bird voices. The Tennessee was recorded May 14th, 16th and 17th in diminished numbers but not again that season. A similar, though numerically less conspicuous movement, occurred on May 9 and 10, 1939.

Regarding the song of the Tennessee warbler, Farwell in Chapman's Handbook (1907, p. 85-86) describes it as: "Very loud, beginning with a sawing, two-noted trill, rather harsh and very staccato, but hesitating in character, increasing to a rapid trill almost exactly like a chipping sparrow, a noticeable but not musical song."

This bird is known to nest sparingly in the northern Adirondacks.

Nashville Warbler* *Vermivora ruficapilla ruficapilla* (Wilson)

Length 4.75 inches. Male, head and nape gray; a more or less veiled chestnut crown patch; white eye ring; remainder of upper parts olive or olive-brown; no wing bars; below yellow, whitish on belly. Female similar, but paler and without crown patch.

This beautiful, loud-voiced warbler may be indicated as a common transient in the Albany area from early May to early June, and early August to or through mid-October. Local summer records also are known.

Among the warblers of Washington Park, the Nashville ranks fourth in frequency of occurrence; the myrtle, black-throated green and northern yellow-throat are first, second and third, respectively. It should be borne in mind, however, that the "season" for the myrtle is considerably longer, from April 12th, our earliest park date for it, to May 20th the latest seasonal date; while the inclusive dates for the Nashville extend from April 30th to May 20th. On a total of 250 field trips taken 1933 to 1942, inclusive, the myrtle warbler was recorded on 110 and the Nashville on 46. If, however, we consider the abundance of the two species from April 30th to May 20th, the period when both were present, we find that the myrtle warbler was observed on 93 of the 121 trips taken while the Nashville was recorded on 46. In both numbers and frequency of occurrence, then, the myrtle is considerably more prevalent than the Nashville.

Only in 1938 did we record the bird as early as April 30th; in most years it was not seen until May 5th. The last spring date was usually May 19th or 20th.

Whatever the Nashville may lack in numbers in the park it more than compensates for by its loud and persistent song. At the height of the spring movement, about May 10th to 16th, the song of this full-voiced warbler is one of the dominant bird utterances among the leafy branches of the high trees where it is difficult to follow with the eye. Sometimes it descends to the lower branches or even to bushy thickets where the persistent observer may have a brief opportunity to associate the results of his ocular and aural observations, so that at a future time he may be more certain of field determination from only one of these types of information.

One of the favorite park haunts of the Nashville warbler is the group of tall silver-leaved poplars just north of the west end of the lake near the junction of the park road and Thurlow terrace. We have spent many exasperating moments there, craning our necks and straining our eyes in an effort to catch even a momentary glance of a singing individual. Such efforts are less necessary, however, when on a bright May morning a "wave" of birds arrives and the leafy canopy resounds with their notes. The many tall elms distributed about the park also are favorite resorts of these birds.

The commonest song of the Nashville warbler is sometimes written *"tawee, tawee, tawee, tawee, tawee titititit"*; the first notes are uttered rapidly and the last ones are like a twitter.

Local nestings of the Nashville warbler have been recorded but most individuals move on farther north to rear their young. The nest, comprised principally of bark, grass, pine needles and rootlets, is constructed on the ground. Three to five eggs usually deposited in late May or early June comprise the usual complement.

Northern Parula Warbler* *Parula americana pusilla* (Wilson)

Length 4.5 inches. Male, above blue with the mid-back greenish yellow; two broad, white wing bars; breast yellow, belly white, with blackish or reddish brown across the upper breast as a band. Female, similar but paler blue above and without or with faint breast band.

This little warbler usually occurs in the Albany area as a moderately common transient throughout May and again in September. During the nesting season, it appears to be most common on Long Island and in the Adirondacks and Catskills.

Our observations in Washington Park indicate that the parula warbler occurs rather sparingly and irregularly. It was not recorded in the park in 1933, 1936, 1938, 1941, 1942 nor 1943. While May 4, 1944, is our earliest seasonal date, other first observations for it usually vary from May 9th to 18th and 19th. In 1940, the season of apparently greatest frequency of occurrence, this bird was recorded on four of the nine early morning trips taken May 9th to 18th, inclusive. In all we listed it 14 times during the entire study.

As with so many other species and subspecies, the male parula is much brighter in plumage than the female. His contrasting colors of bluish upper parts and dark banded breast make this beautiful small warbler's appearance quite noticeable when he emerges into an opening between the leaves.

Ordinarily the parula does not frequent the highest parts of the park trees as much as the lower branches. Such portions of the tall, silver-leaved poplars near Thurlow terrace are a good place to find this bird. In season, its familiar buzzing trill, uttered in an ascending scale and often ending in a low-pitched *"tup,"* first directs one's attention to it.

Probably because of its liking in this region for low, more or less boggy and moist situations, in both the nesting period and throughout migration, this warbler visits Washington Park less commonly than were such favored situations offered there. The parula often selects balsam and tamarack swamps in which to nest.

Eastern Yellow Warbler* *Dendroica petechia aestiva* (Gmelin)

Length 5 inches. Male, above bright greenish yellow, brighter on crown; tail greenish with inner vanes of feathers yellow; below bright yellow streaked with reddish brown. Female, similar but greener above, and paler and slightly, or not at all, streaked below.

Strangely enough, although it is a common summer resident throughout the outlying sections of the capital district, the "summer yellow bird" scarcely can be noted as even a common transient in Washington Park. From early May (occasionally late in April) to late September, this yellowest of our warblers sings and rears its young about isolated country homes and gardens, as well as in the bushy thickets of urban and suburban districts.

We have recorded the yellow warbler in Washington Park every season save those of 1933 and 1934, and have listed it on a total of 26 mornings which is the same number for two other members of the warbler family, namely, the black and white warbler and redstart. It therefore ranks 11th among the members of its family in frequency of occurrence in ten years of study. Our earliest park date is May 3, 1936. Other first spring dates vary from May 4th to May 12th. The rather limited spread in these dates of early arrival suggests a more uniform migration in the yellow warbler than characterizes most of the local wood warblers. Apparently the males habitually precede the females. Our latest spring date for the park is May 20th.

In Washington Park the yellow warbler occurs more frequently in the lower branches of the taller trees than in the bushes and shrubbery which it is so accustomed to haunt during the nesting season. We suspect that it is mainly the proximity of so many people and the disturbances associated therewith that prompt this active, brightly colored, loud-voiced songster to remain high up in the trees during its comparatively short sojourn in the park.

Singing is one of the activities in which this bird excels. Whatever lack of melody its voice may possess is compensated for by the persistence and enthusiasm with which it performs. The song is subject to variations; one type is expressed thus by Saunders (1923, p. 322): *"swee-swee-swee-swee-te-te-te-swee."*

The yellow warbler is not a woodland species but an inhabitant of thickets and low bushes of open country in the vicinity of water. Suitable nesting situations are frequently found, however, about the vines and shrubbery of country homes. As the nesting season approaches, its sociable and unsuspicious tendencies with respect to man become more marked. Indeed, it appears to enjoy his society and having once established the domicile, perhaps in a vine or bush at the side of a house, it seems little concerned by the comings and goings of its human neighbors.

Nest building is accomplished mostly by the female but the male lends encouragement to her efforts by redoubling his vocal efforts. The nest usually is placed in a tree or shrub three to ten feet above the ground. It is large, compact and firmly woven into the crotch of a supporting branch. Plant fibers, grasses, pieces of bark and plant down comprise the principal materials. A lining of down, fine grasses or feathers is usually provided. Four or five bluish white eggs speckled with dark comprise the usual complement. Incubation, performed mainly by the female, requires about ten days and the same amount of time elapses before the young are ready to leave the nest.

The yellow warbler is one of the species upon which the cowbird frequently imposes its eggs. In an effort to avoid incubating the egg of this parasitic species, the smaller warbler sometimes constructs one, two, three or even more floors in its nest, over each egg a cowbird has deposited. Even then it does not always avoid the responsibilities of a foster parent.

The yellow warbler is largely insectivorous. This habit, together with its abundance throughout its summer range, combine to render the species an important agency in preventing the undue increase of many small insects which are often overlooked by larger birds. To its practical merits may be added also the esthetic qualities of voice and appearance, all of which unite to give the "wild canary," "yellow bird" or "summer yellow bird," high rank in popular favor.

Magnolia Warbler* *Dendroica magnolia* (Wilson)

Length 5 inches. Male, above black, the feathers margined with greenish; crown bluish gray; cheeks and forehead black; a white line over and behind eye; a large white patch on wings; rump yellow; tail black with a conspicuous white area; below yellow, heavily streaked with black on breast and sides. Female, similar but duller; back greenish.

This conspicuous, contrastingly colored and distinctive voiced woodland warbler is a common transient and nests sparingly in the Albany area. It occurs regularly in Washington Park where it usually puts in its first spring appearance about May 10th. Our earliest spring record for it there is May 3, 1938; we have noted the bird in the park as late as May 31, 1939.

The number of magnolia warblers which visit the park varies considerably from season to season; sometimes the species appears to be scarce and late in arriving; again in other years it is common and then, during the height of its migration period, it is one of the conspicuous warblers, both in presence and song. During the spring movement this warbler is not noticeably partial to any special habitat though perhaps it occurs a little more commonly in mixed woodlands. During the first ten years of this study we observed the magnolia on 36 trips. It, therefore, is rated as the fifth of its family in frequency of occurrence in the park.

The magnolia, sometimes called the black and yellow warbler, usually remains among the higher branches of trees, but its habit of conspicuously fluttering while it feeds, may help somewhat the plight of the bird student who seeks to identify it. As the bird rapidly vibrates its wings while peering along a leaf or twig the black, yellow and white plumage, especially the black tail with the conspicuous white basal area, is prominently displayed. If under such conditions, the field observer is able to obtain but a fleeting glance of the bird he can be reasonably sure of the identification.

As with so many of the wood warblers, the song of the magnolia is subject to considerable variation. Its usual or typical song, however, is reasonably distinctive and may be syllabled as *"we-eto, we-eto, we-ee-to."* The first four notes are uttered slowly, the last three more rapidly and at a higher pitch.

Coniferous forest areas provide the principal nesting habitat of the magnolia warbler. It is one of the common summer birds of the Adirondacks. The nest is said to be placed usually in a small spruce or hemlock not far above the ground, and to be composed principally of twigs, pine needles, grass and fine rootlets. The usual complement of eggs is four. In late September or early October the magnolia leaves for winter quarters in Mexico and Panama. One of these fall transients was noted in Washington Park, September 29, 1943.

Cape May Warbler *Dendroica tigrina* (Gmelin)

Length 5 inches. Male, above olive-green, streaked with black; crown black; cheek patch chestnut; rump yellow; a conspicuous white wing patch; below mostly yellow, whitish on belly; breast and sides streaked with black. Female, similar but duller, and lacking the chestnut cheek mark.

Within recent years the local status of this warbler appears to have changed from that of an "irregular, very uncommon transient" to that of regular, uncommon transient. In other words, the bird's numerical status and consistency of occurrence seems to have been stepped up. Judd (1907, p. 164-65) did not include the Cape May in his Washington Park list, but he reported it as a very rare migrant in the county. May 2, 1942 and May 19, 1940, were our earliest and latest dates for the appearance of the Cape May within the boundaries of Washington Park. The striking male of this species with his chestnut cheek patches was first recorded by us in 1936. Again in the next year one bird of the same sex was listed, while in the succeeding two years we noticed it three times in May within a week; from then on our lists for Washington Park included the species annually for the next four years. Of our 13 records only twice, May 15, 1939 and May 13, 1942, did we see two males. On all other trips a single bird of that sex was noted. In the first ten years of this study, the longest stopovers for the species occurred in 1938 and 1939, when the bird was recorded on May 6th, 13th and 14th in the first year and May 10th, 12th and 15th in the second. According to field notes for May 13, 1938, "Its song, which somewhat resembles that of the black and white in phrasing but is not as squeaky, is in decided contrast to that of the voluble Tennessee and pine warblers which are in full song this morning." This bird, like many other warblers, varies its song.

In 1946, this species was unusually abundant for the week of May 12th to 19th, as it was seen and heard in several parts of Washington Park. An unforgettable sight for the junior author on May 13th, was of a Cape May, a Blackburnian and a magnolia, all seen in the bright sunshine on the branches of a single larch tree at the west end of the lake. They sang intermittently while inspecting the larch buds for insects, thus giving the observer a fine opportunity to note the difference in the songs of these three closely related birds. This record emphasizes the possibilities of a city sanctuary for observation of warblers.

The pines and larches near the lake were the Cape May's favorite trees, but it was also seen and heard in other localities such as the tops of elms and silver-leaved poplars and in the branches of the maples. Fall records from September 7th to October 9th, as well as summer dates, are given by Bartlett (1937, p. 15).

An interesting record for the northern part of New York State is included here as it is descriptive of the habits of this species and shows its scarcity. Mrs Louise C. Blake, who has been a bird student for many years in the Potsdam area, writes: "I saw the Cape May warbler for the first time on May 15, 1944, and it was a real thrill. I studied him at close range for one-half hour. He is a very quiet little fellow, very intent on his business, and not as excitable as most warblers. He was extremely beautiful. I also saw him several times after that." The above-mentioned bird was feeding among cherry buds and blossoms. Authorities state that their food consists largely of insects and that they are known to be beneficial to trees and shrubbery. This appears to be the first record for the Cape May warbler in St Lawrence county.

Northern Black-throated Blue Warbler

Dendroica caerulescens caerulescens (Gmelin)

Length 5.25 inches. Male, above grayish blue, sides of head black, a conspicuous white patch on wings; below with throat and sides black, the breast and belly white. Female, above olive-greenish, a small whitish patch on wing and a narrow pale line above the eye; below brownish yellow.

This common transient visitor to the Albany region was recorded as being more numerous in Washington Park in some years than in others. It was heard or seen on one or more trips every year between 1933 and 1944, except in 1936 and 1943. In 1934 and 1939, we reported it on just one field trip and in 1935 and 1941, on two mornings each. Sometimes a single individual would be all we could list, then on other occasions, one of which was May 19, 1937, several birds were observed and we noted: "Has been persistently present for a week, much more in evidence this season than the black-throated green." Again in 1942 we noted: "More persistently present than usual. On the ten trips taken between May 6th and 19th, we have recorded this warbler six times." It was seen over a period of 12 days in its six appearances in 1938. In all we listed the bird 32 times which makes it the seventh warbler on our frequency of occurrence table of years 1933 to 1942.

Our earliest park record was May 1, 1940, although the black-throated blue did not usually appear until May 6th, and in 1939, it was not observed until May 19th. Our latest spring date was May 20, 1941.

On the hot afternoon of July 9, 1937, we heard this species singing in Thacher State Park, which date suggests that it probably breeds there. This is only about 15 miles from Washington Park. Other near-by localities are possible nesting sites.

An observer's attention is called to this small bird usually by hearing its rather hoarse wheezy *"zwee zwee zwee"* long before it is seen in the top of the trees. Having located the strikingly colored male among the leaves, one can take great pleasure in inspecting his beautiful plumage with field glasses. It is easy to recognize the male black-throated blue for his name describes him, but the female is an obscure and inconspicuous bird with no black on her head or throat; the white wing patch, however, is diagnostic.

Forbush (1929, Vol. II, p. 236) says: "The black-throated blue warbler, like others of its family feeds largely on moths, caterpillars including the hairy tent caterpillar, flies, beetles and plant lice . . ." It is therefore a beneficial species to have even as a visitor in our city park.

Eastern Myrtle Warbler *Dendroica coronata coronata* (Linnaeus)

Length 5.5 inches. Male, above bluish gray, streaked heavily with black; a yellow patch on center of crown, on each side of the breast and on the rump; below white, the breast heavily marked with black. Female with brown replacing the bluish gray. Call note a distinctive *"tchep."*

During migration the myrtle is the most abundant warbler in Washington Park and it is seen here every spring. Not only is it the commonest of the wood warblers but it usually stays longer than any of the others. On some occasions it occurs in such numbers as to suggest flocks.

The male with its four conspicuous bright yellow patches and bluish gray back is easily recognized in spring without the aid of field glasses. His mate shows similar markings, only duller, with the back quite brownish. In fall the male, too, is brownish.

We often observed the myrtle warbler in surrounding Albany territory before seeing it in the park. Usually only one or two males were first noted, then one or two females soon appeared. From then on greater numbers of both sexes were listed until it was clearly the commonest warbler. It was seen on 110 of the first 250 trips taken during this study and ranks 16th on our frequency of occurrence table. The following field notes are inserted to show variation in abundance and length of stay of this species.

> "April 30, 1936. Much commoner than three days ago. Its monotonous chatter, a little like that of the slate-colored junco, is heard on all sides.
>
> "May 12, 1937. This warbler and the goldfinch, the two dominant species in the park just now.
>
> "May 16, 1938. The only warbler that is at all common. As a matter of fact, this bird ranks second in abundance of all the species in the park this cold morning. It is surpassed in numbers only by the English sparrow.
>
> "April 30, 1942. Common this a.m. Evidently a marked 'wave' of the bird has occurred locally during the past 24 hours. Both males and females this a.m.
>
> "May 6, 1942. Seen and heard in abundance on all hands. Evidently at maximum of abundance here now.
>
> "May 13, 1942. Numbers have fallen off.
>
> "May 6, 1944. At no time to date has this warbler been as common as in previous years. The same is true of other warblers and the sparrows as well. Many species have appeared 'earlier' than usual during those first few warm days but the numbers of small species are noticeably reduced."

April 15, 1941, was our earliest park record and also a very early date for it in this territory and May 20th, of the same year, was our latest record. It is interesting to note that on a total of 28 trips taken between these two inclusive dates, the myrtle was observed on 23. It was recorded on 15 mornings each during 1938, 1939 and 1942.

This very active, restless, large warbler has been seen both high and low in trees or bushes, darting about for insect food. Sometimes several may be feeding in and out of one tree while frequently uttering their loud *"tchep"*; occasionally they will pause and burst forth in beautiful song. Various insects, seeds and berries are eaten but the favorite food of this rather tame warbler in certain localities consists of the fruits of the bayberry or wax myrtle (*Myrica*), and it is from this trait that it derives its name, myrtle warbler.

While the myrtle winters as far south as Panama, large numbers occur in central and southern Florida especially in January, February and March. Some years ago the senior author submitted a report as a cooperator of the Biological Survey and field assistant in Bureau of Entomology, United States Department of Agriculture, on The Relation of Birds to the Celery Leaf-Tier and Associated Celery Insects in the Sanford, Florida Celery District. It was found in this specialized study that the following birds (which visit Washington Park in migration) namely, the tree swallow, and myrtle and western palm warblers rank first, third and fourth, respectively, as beneficial birds in this 4000 acre area. Examination of 36 stomach contents of myrtle warblers showed that 35.60 per cent of the food was lepidopterous of which 16.87 per cent was the celery leaf-tier, probably the most destructive pest of celery; 20.58 per cent was *Diptera,* 13.62 per cent *Hymenoptera* and 10.27 per cent *Coleoptera.* This gives a brief glimpse of its beneficial status in only one small section of its winter quarters. For its food habits, as well as for its esthetic value, the species is deserving of protection.

Other names by which this species is known are "yellow-rumped," or "yellow-crowned," warbler. Sometimes it is designated as the warbler with four yellow patches, perhaps to distinguish it from the magnolia which also has a yellow rump.

Margaret McKenny (1939, p. 193-94) mentions the occurrence of this bird during migration in gardens near the downtown business section of New York City. This is further evidence that it is not averse to pausing in other and larger cities during its migration. We do not often find it nesting in this zone, the Transition of Upper Austral, but rather it is a breeder in the more northern Hudsonian and Canadian zones.

Northern Black-throated Green Warbler

Dendroica virens virens (Gmelin)

Length 5 inches. Male, above bright olive-green; side of head yellow; throat and breast black; belly white, flanks with black streaks; two white wing bars, white in tail. Female, duller above and with less black below, throat yellow.

From 1934 to 1944, this very common transient visitor was seen and heard every year in Washington Park. The earliest and only April record which is also an early one for this territory was on the 30th in 1942. May 1, 1941, was another notable first record as ordinarily the species was not observed until about a week later. In 1938, it was heard as late as May 30th. Usually the bird attained its height of song between the 9th and 17th of May.

We listed the black-throated green on 47 mornings, which is considerably below the myrtle's 110, but this still gives it second place in frequency of occurrence among warblers during the first ten years of this study.

There is something soothing and restful about the song of the black-throated green; it appears to utter it so easily compared with the black-throated blue. Its rapid, musical *"zee-zee-zee-ZEE-zee-zee"* or *"zee zee zee zu zi,"* seems natural woodland melody. After a bird student has learned to know this beautiful melody, he realizes that, although not loud, it is characteristic of the morning chorus. We associated this species with the tops of tall trees and seldom, if ever, have seen it low or near the ground in the park. It was often heard in the tall poplars on the slope north of the lake but it did not confine itself solely to that section. It was probably identified easier by song than by sight as it generally was well hidden by the leaves high up in the trees.

In the Oneida Lake region we found the nest of the black-throated green in a tall hemlock tree in a mixed forest. There were four young warblers together with a fledgling cowbird in the nest which was some 40 feet above the ground. It was near the top of the tree and was constructed mainly of pine needles. The eggs had evidently been laid about the end of May or early in June, for the nestlings were about eight days old on June 20th.

The black-throated green was listed in near-by Thacher State Park on May 16 and July 9, 1937, and also on May 2, 1938. A rather late fall record for that park was October 4, 1936, when the one bird of the year was observed in a small cedar along with kinglets and goldfinches. The adult male in fall and immature males have plumage similar to that of the female but show less black and much more yellow on the chest. The above summer and fall dates indicate that the bird nests in Thacher Park which is situated about 15 miles from Washington Park.

Blackburnian Warbler *Dendroica fusca* (Müller)

Length about 5.25 inches. Above, black streaked with whitish; prominent color spot on fore part of crown; line above eye which extends back of black ear coverts and large patch on throat and breast, deep orange; other underparts white, tinged with orange and black streaked. Female markings similar to those of male but colors less vivid.

This fairly common transient park visitor is a summer resident in the Albany territory. It was observed by us every year 1933-42, except in 1934, on a total of 20 morning trips. In 1944, we had the early date of May 2d for both sexes while in 1940, no individuals were recorded until May 19th; in 1941, another late first record was May 20th. In 1941, a male was seen in the larches on Englewood place on June 2d, and several others were observed on that date in other sections of the park; one female was noted on June 7th, our latest date for it in the park. This means that the Blackburnian was in this bounded city area over a period of nearly three weeks in 1941. Its visits in other years were much shorter, usually for about one week.

On May 4, 1942, this beautiful bird was heard and seen in several sections of the park so apparently a flock appeared here on that day; we did not have any previous or subsequent records for this year.

The male Blackburnian is one of the most striking warblers seen in this region because of the bright orange or flame color in its plumage. So prominent is the color that the bird can be easily seen and recognized without the aid of binoculars when it flutters in and out of the foliage. It may more often be heard and recognized as it utters in a fine wiry, high-pitched, more or less metallic voice its characteristic "*zee-zeu-zee-ee-e-e,*" which ascends in pitch toward the end.

The status of this warbler in this part of the State seems to have changed since Judd (1907, p. 55) recorded the bird as a fairly common migrant in Albany county. William Carr (1940, p. 15) gives its status in Bear Mountain Park, which is about 100 miles south of Albany, as, "rare summer resident, breeds, irregular migrant, April to September." Kendeigh (1945, p. 154) notes nest construction near completion on June 18th for one pair in Rensselaerville which is about 30 miles south of Washington Park. It is found to be rather common in breeding season near the top of Mount Greylock, Berkshire county, Massachusetts, about 40 miles east of here.

During the summer the magnolia, black-throated green and Blackburnian warblers are usually confined to spruce, pine or hemlock forests according to W. L. McAtee (1926, p. 18). Like other wood warblers the Blackburnian takes many moths and caterpillars and feeds on larvae as well as adult forms of beetles infesting trees. It is, therefore, recognized both for its economic and esthetic value to mankind.

Chestnut-sided Warbler *Dendroica pensylvanica* (Linnaeus)

Length about 5 inches. Male in spring with yellow crown; a conspicuous black streak behind and another below the eye and extending down the side of throat where it merges into a wide chestnut stripe; back streaked with black; ear coverts and belly white; wing bars yellowish white; tail black with white markings. Female in spring similar, but colors less distinct.

This bird is a common summer resident in Albany territory. We recorded it every spring season, 1934-42, on a total of 27 trips. It therefore ranks eighth among the warblers in frequency of occurrence table in Washington Park. On the morning of May 14, 1934, when we first listed the chestnut-sided warbler and on the following day, this species along with the myrtle and magnolia, appeared to be the three commonest warblers in this area.

One male, observed by the junior author conducting a group of American Association of University Women on a field trip on April 28, 1938, gave the earliest park record and also an early regional record; the chestnut sides and yellow crown were observed at close range by the entire group. The bird was quite conspicuous and made a pretty picture in the early morning sunshine as it darted in and out of low larch trees near the west end of the lake. He was singing while feeding among the young buds of the tamaracks and was not especially disturbed by the seven ladies who listened to his beautiful song and watched him for about ten minutes. This was the only warbler on the list of 22 birds noted that morning. Previously, in the same season the authors had recorded only two other warblers, namely, the western palm and the myrtle.

Also in 1938, we noticed this species five times more up to and including May 18th. On this date we reported it thus, "has been one of the common warblers of the park during the past few days." Usually we did not note the bird on so many trips each year or over so long a period. Other first dates for the chestnut-sided were May 4th in 1942 and 1944. There were several spring seasons when we did not see it until between May 10th and 15th. Our latest spring record was May 20, 1941.

The two following records illustrate the proximity of the summer residence of the chestnut-sided to Washington Park. Pine Bush, near Karners and six miles northwest of Albany, provides an extensive suitable nesting habitat for this warbler and several others as well. Here on June 19, 1940, we saw a female carrying food for young. Huyck Preserve, Rensselaerville, about 30 miles southwest of the city, is another nesting site where we listed the species on July 21, 1937.

One fall record of Washington Park is of interest because of the number of young seen together. On the warm sunny afternoon of September 15, 1943, four immature birds were observed for some time by the senior author while they were feeding amid the foliage of elms.

Not only is this sprightly warbler pleasing to the eye but its full-voiced song is one of the most melodious of the spring chorus. Since it is highly insectivorous, it is beneficial as well.

Bay-breasted Warbler *Dendroica castanea* (Wilson)

Length 5 to 6 inches. Male, chestnut on crown, throat, upper breast and sides; black on forehead and cheeks; underparts whitish; two white wing bars. Female, crown olive-green and back brownish gray streaked with black; buffy-white underparts with more or less chestnut at the sides.

This large warbler was not commonly seen in Washington Park, as we have only two records for it. On May 10, 1937, we saw a male in the tall poplars in the western section of the park; this is quite an early date for it in the Albany area. Other warblers observed on this cool morning were the Blackburnian, myrtle, black and white, parula and Nashville. One bird was plainly seen in the tops of the elms about the croquet grounds on May 19, 1946, by the junior author. Eight other warblers were listed on that warm sunny morning, some of them in those same trees, and in the general chorus she was unable to distinguish the song of the bay-breasted, which is said to be very high and squeaky according to May (1939, p. 435).

Bartlett (1937, p. 15) in a booklet entitled Birds of Eastern New York, gives the status of this warbler as follows: "Not uncommon transient visitor, late May, mid-September, with maximum dates of May 6, 1928 to May 30th of various years, also August and October records." So it seems rather surprising that between 1933 and 1946, we saw only two male birds on only two trips. Part of this paucity of record may be because other ornithological work took us away from this study most of the years between May 21st to 30th, when we could have missed this visitor; also it is known to be a bird more of dense woods than of city parks both during migration and nesting periods.

Eaton (1914, p. 417) reported the species fairly common in Albany county but not arriving until May 15th to 30th. Judd (1907, p. 165) included the bird in his Washington Park list but called it an uncommon Albany county visitor with none seen in some years.

In Oneida Lake studies we saw it in the seasons of 1928 and 1929, and called it a fairly common and regular, though rather late, migrant. It was seen in tall maples near a small village on the south side of the lake and again in hemlock woods some three miles north of the village of Cleveland, New York, on the north side of the lake. We even had an apparent "wave" of male bay-breasted warblers, seeing 20 on May 25, 1929, within two hours. These were in a thicket of beech, maple, birch, ironwood, ash and elm saplings in a woods on the north side of Oneida lake. Here we approached to within a few feet of these beautiful birds as they were feeding and preening themselves in the sunshine.

It is very difficult to distinguish the bay-breasted from the black-poll in autumnal plumage. Then, too, at this season both species keep close to the tops of trees and the observer may not be able to see any definite markings in his brief glimpses of the birds fluttering among the leaves.

Black-poll Warbler *Dendroica striata* (Forster)

Length 5.5 inches. Male, crown black, back greenish streaked with black; below white, heavily streaked with black. Female, without black crown, grayish green above; below yellowish white, streaked with black.

The black-poll is a fairly common transient migrant in the park as we recorded it every year except in 1933 and 1935, on a total of 15 mornings during the first ten years of this study. Perhaps the reason for the lack of more numerous observations especially in the two years mentioned was that very little field work was done after mid-May. The junior author found the black-poll unusually common in the later part of May during the 1945 and 1946 seasons. This bird is one of the later warblers, yet not the last one to arrive. As far as our park list goes, we find it is one of the two latest, its tardy companion being the mourning. Our earliest date varies considerably from May 15, 1934 to June 3, 1942. Often we did not list the black-poll until nearer the end of May and then usually a single individual was seen. Greater numbers, however, were observed during the main stay of the species which sometimes extended over two weeks. For instance, one male was recorded on May 20, 1940, and on June 1st, several individuals were heard singing; their high-pitched, bouncing notes were much in evidence in the morning chorus in the park.

The bird was more conspicuous from its frequent vocalization than for its visible appearance. May (1939, p. 436) described the song as a "high-thin monotonous '*zi-zi-zi-zi-zi-zi-zi*' all on one pitch or swelling in volume in the middle." The song reminds one of a bouncing ball. It is quite characteristic and noticeable as it is repeated over and over. Then, too, the song of this late arrival is perhaps more noticeable as it is heard later in the season when most of the other warblers have gone north.

Sight identification of the black-poll in the autumn is rather difficult because not only are the parents and young alike but they closely resemble the bay-breasted in its fall plumage. On September 15 and 22, 1943, the senior author observed a number of individuals feeding amid the leaves of the tall elms (many of these leaves had been attacked by a greenish lepidopterous larva). Then a week later he recorded the black-poll as still here but not so common, which shows that the species tarried here for two weeks before continuing its southern trip. In the fall the song was heard infrequently. Perhaps this warbler lingered both in the spring and fall because of the need of rest and food as it has one of the longest migration routes of any of the warblers. It breeds north to the limit of trees and winters in the northern part of South America. Chapman (1907, p. 15) says, "The shortest journey that any black-poll performs is 3500 miles, while those that nest in Alaska have 7000 miles to travel to their probable winter home in Brazil."

The bird is quite beneficial to our orchard, elm and other trees in New York State for it feeds upon plant lice which infest blossoms and leaves. It feeds upon harmful caterpillars also and a flock has been known to clean up infestations of certain trees in an orchard.

Northern Pine Warbler *Dendroica pinus pinus* (Wilson)

Length 5.5 inches. Male, above olive-green; two white wing bars; below bright yellow, faintly streaked on breast. Female, similar but duller; breast whitish, tinged with yellow.

The pine warbler, although not seen inside the city every year, is fairly common in the surrounding area. On April 24, 1936, one male was noticed in the southwest sector of the park, in larches near the lake. This was not only our earliest record for the Albany region but it was also the first year we had observed this species in Washington Park. It was seen there every spring thereafter until 1942, on a total of 13 trips. In several years it was noted but once; in 1938, however, field notes for May 9th, 12th, 13th, 14th and 18th describe its prevalence, song and length of stay. While several individuals were noted on each of these dates, there had been a distinct influx of the pine warbler during the first week of this period. On the first morning mentioned the birds were found in tall elms near the center of the park. Here their loud trill reminded us of that of the chipping sparrow; they were easily distinguishable above the other avian voices and the city noises. On the second date we reported them as one of the prominent bird voices in the park. On the last date they were not quite so prevalent, but still evident enough for us to note that: "The two most conspicuous voices heard today were those of the pine and Tennessee warblers."

In the following year the species was listed on three widely separated dates, namely May 9th, 29th and June 7th. A single female was seen on the latter two dates; this caused the note comment, "Can the bird be nesting here?" This, however, was our latest date for the park.

Evidence of the pine warbler's association with other birds was obtained April 22, 1936, when one individual was identified with a flock of 200 juncos in the near-by country southwest of Albany. Again in quite typical habitat territory in the burned over portion of the Pine Bush area near Karners, about seven miles northwest of the city, we saw this species on May 16, 1941, and had an opportunity to hear its song and to compare it with the faint, lisping trill of the prairie warbler and the harsh phrasing of the yellow-breasted chat.

Circumstantial evidence points to its breeding in this above-mentioned area not far off the Schenectady-Albany road, and although we did not find the nest, on June 19, 1935, we noted: "Several pairs of pine warblers evidently nesting in the tall pines one-fourth mile off route 20, seven miles west of Albany." This bird is sometimes called "pine-creeping warbler." The nest which is made of strips of bark and plant fibers is located 10 to 80 feet up in pine trees and contains four to five marked, grayish white eggs.

One of the shortest migration journeys of the warblers is taken by this bird. It is not known to go south of the United States in winter; in fact, the birds merely concentrate in the southern part of the breeding range.

Western Palm Warbler *Dendroica palmarum palmarum* (Gmelin)

Length 5.25 inches. Adults, above olive-brown or dull yellow; crown reddish chestnut; yellow stripe over eye; below, throat, breast, yellow; under tail coverts brighter; other underparts whitish.

In only two years did we observe this uncommon and irregular migrant in the park and then only one sight record in each season was reported, namely, on May 15, 1934 and April 29, 1942. On the latter date a single bird was seen in the thicket of the vacant lot on the east side of Thurlow terrace near the north edge of the park.

The whitish underparts and smaller size help to identify the western palm from the yellow palm warbler. Both birds have the habit of flirting or wagging the tail much like the phoebe.

The call *"tsip,"* is heard rather frequently as the bird feeds about or near the ground. This is softer but somewhat similar to that of the *"tchep"* of the myrtle warbler, which, however, is uttered much oftener.

This northwestern breeder, which is rare in the eastern part of the United States, spends its winters from Florida to Yucatan. It is very common at that season in the celery district of Florida. The senior author found it to be the commonest bird in celery fields in both the Sarasota and Sanford, Florida districts in an intensive study that he made there several years ago for the United States Department of Agriculture. In this specialized agricultural region, the western palm warbler ranks fourth as a valuable insect feeder during the winter months, November to February. We also observed more individuals of this warbler than the yellow palm in a Christmas census taken for the National Audubon Society at Gainesville, Fla. a number of years ago.

Yellow Palm Warbler

Dendroica palmarum hypochrysea Ridgway

Length about 5.5 inches. Adults of both sexes, above olive-brown; crown reddish chestnut; yellowish stripe above eye; below, bright yellow throughout.

The yellow palm is not as uncommon a migrant in the park as its near relative, the western palm, for we observed it on 11 trips in eight years, namely in 1933, 1934, 1936, 1937, 1940, 1941, 1944 and 1946. The earliest entry for this bird in our notes was April 19, 1934; other early dates were April 21, 1946, April 22, 1933 and 1941 and April 24, 1936. We also have records for its rather late first appearance there on May 2, 1944. In 1937, the only record for it was May 15th and in no other year did we see it later.

Usually this warbler occurred singly. On the earliest date of April 19, 1934, one bird which kept close to the tops of tall trees, was the first warbler listed for that season in the park; the "wagging tail" served to identify this individual. In another year one bird appeared in the lower larch trees near the lake, and at another time, an individual was identified with a flock of juncos and ruby-crowned kinglets. At least four birds with the bright yellow breasts were seen on

April 24, 1936, in the park; they were not together but in three different localities.

The yellow palm does not go as far south as the western palm but winters from Louisiana to Florida. We reported one bird on a Christmas census taken for the National Audubon Society at Gainesville, Fla., several years ago. Four observers taking this census that same year in other sections of that state reported one to five individuals of the yellow palm, while five to 20 western palm warblers were noted on each report.

As a rule both the yellow palm and the western palm frequent fields and gardens; they seem to prefer to live on or near the ground and not in the trees as do most other wood warblers.

Common Oven-bird *Seiurus aurocapillus aurocapillus* (Linnaeus)

Length about 6 inches. Male and female, above olive-brown; an orange-yellow patch on crown and back of head, bordered by narrow black lines; below, white with prominent, black stripes on sides of throat, breast and flanks.

This rather aberrant warbler is a summer resident of Albany county and we found it to be a yearly visitor to Washington Park. During the first ten years' study it was observed on 32 trips, which makes it rank sixth among members of its family in frequency of occurrence. The bird usually arrives about the middle of May but occasionally we have heard and seen it as early as May 4, 1942 and May 6, 1936. Generally one individual was observed on a trip, but on May 13, 1937, and May 4 and 8, 1942, there were two birds in the same sector of this bounded area.

In 1937, it was listed only once; in all other years we recorded it on two to six different mornings. Between May 12th and 18th in 1938, and May 7th and 20th in 1941, it was observed five and six times, respectively. The latest spring record was June 1, 1940. Dates for its appearance in the park extended over a period of about two weeks in 1936, 1940, 1941 and 1942.

The oven-bird's song is easily recognizable in the morning chorus for it sounds like the words *"teacher, teacher, teacher, teacher, teacher."* With each repetition, the word *"teacher"* grows louder until with the fifth, and sometimes sixth, utterance it is so loud that it resounds not only in the immediately surrounding area but it may be heard some distance away. The frequent utterance of the characteristic song is one of the reasons why the bird is more often heard than seen and why it is called "teacher bird." The oven-bird is usually seen walking among the leaves on the ground looking for insect food which forms the greatest portion of its diet. The yellow patch on top of its head is plainly visible (without binoculars) and this color marking helps both to identify and to differentiate it from the thrushes with which it is sometimes confused.

The name oven-bird refers to the bird's partially covered nest that it builds on the ground and which suggests an old-fashioned, outdoor oven. The roof of the nest is covered by leaves, while the small opening is on one side. With the leaves more or less concealing it, the nest is very difficult to find.

Louisiana Water-thrush *Seiurus motacilla* (Vieillot)

Length about 6.25 inches. Male and female, above uniform olive-brown with a conspicuous white line over eye; below buffy-white, sides of breast streaked with black.

Our records indicate that this bird is a rather uncommon visitor in the park. A solitary individual was reported for only one trip each in 1934, 1936, 1937 and 1938, and on two trips each in 1940 and 1941; in the last year, one bird was seen on each of the last two days of May. This May 31st record was also our latest, while May 6, 1945, was the earliest date. It is interesting that the nine appearances noted in the park were all on rather cold May mornings when the temperature varied from 40.0° to 55.0°. The loud ringing song was heard on two occasions before the observers located the bird near the lake house. It was always seen at the edge of or near the water; this preference for streams, though a terrestrial warbler, and its resemblance in coloration to thrushes, have given it the name, water-thrush.

This species, along with its close relative, the northern water-thrush, has the habit of teetering when standing on the ground or on a limb and of walking with a tilting motion like a sandpiper. This has suggested the name, "water wagtail."

The call note, a loud *"chink,"* may often be heard long before the bird is seen. Chapman (1932, p. 472) says, "As a songster the water-thrush is without rival . . . It is the untamable spirit of the bird rendered in music. There is an almost fierce wildness in its ringing notes." When an observer hears the sudden outburst in Washington Park he is reminded of the bird's natural habitat, for it is so distinctly a sound of the woodland gullies and ravines. The nest, which is made of leaves, twigs and rootlets, is often placed under a bank or among the roots of a fallen tree. Breeding pairs are reported sparingly in Albany county.

Mourning Warbler *Oporornis philadelphia* (Wilson)

Length about 5.25 inches. Male, above olive; top and sides of head and throat gray, upper breast black; belly yellow, sides tinged with dusky. Female, similar upper parts; head gray, breast grayish, throat whiter.

This rather uncommon but striking looking visitor was noted only in 1938, 1940 and 1941, in Washington Park. The mourning warbler is one of the latest of the migrants to arrive. It winters in Central America and northern South America and reaches the United States late in April or early in May, Chapman (1907, p. 246). Our first and last dates for its appearance are May 17 and June 7, 1941. This species and the black-poll are the last two wood warbler arrivals in Washington Park in the vernal season.

We had ample opportunity to watch and hear a male mourning warbler on May 31, 1938, when we saw him remain for several hours among the thick, low bushes near the State Street and Northern Boulevard entrance of the park. Most of the time the bird kept well concealed but occasionally he perched on a long twig in full view, and sang his song over and over; his singing was both loud and long. Despite the fact that these bushes border one of the main thoroughfares of the park where motor cars are constantly passing, this individual did not leave them.

The second appearance of this warbler listed in our notes was for June 1, 1940, when: "A male evidently came in within the past 24 hours with a 'wave' of redstarts and other unusually late arrivals. The song at once attracted attention and we located the singing bird in the top of a tall elm near State street."

Again a solitary male was seen and heard on May 17, 1941, when it remained well concealed, but singing, in a bushy thicket in a vacant lot off the northwest sector of the park. The mourning warbler was listed also on May 20th and June 7th of the same year; on the latter date, a male was again singing as it remained more or less concealed in a bushy clump along the roadside near the lake house.

In the spring this handsome male bird can be recognized by his darkish head and black bib and it is from this he receives his name and not from the cheerful song which is like a loud, more or less warbling, whistle. During the breeding season the male is less skulking, perching at times in the top or near top branches of a tree (often a dead one) and joyfully uttering his musical message. As a member of the Schenectady Bird Club, the junior author had the opportunity June 23, 1946, of witnessing this performance near the top of Mount

Greylock, at 3490 feet elevation, of the Green Mountains in Massachusetts not far from the New York State line and about 40 miles distant from Washington Park. Occasionally the bird flew down to the roadside thicket below, which was probably near the nesting site as authorities state that the nest is either on or near the ground. The species breeds as far northeast as Newfoundland but migrates southwestward reaching South America and avoiding the South Atlantic states and the West Indies.

Northern Yellow-throat

Geothlypis trichas brachidactyla (Swainson)

Length about 5 inches. Male, back, dark olive; throat and breast, bright yellow; belly white; black mask across forehead and over cheek, bordered behind by narrow grayish white. Female, similar but without mask.

This common summer resident ranks 33d in our table of relative frequency of occurrence of the 50 commonest species in Washington Park; it was recorded on 47 mornings out of the total of the first 250 trips taken during this study. Only the myrtle and black-throated green of the wood warbler family surpass it in reoccurrence. It was especially prevalent in 1938, when we observed it on all but one of 11 trips taken between May 6th and May 19th. More individuals were noted also in this year as we remarked on May 18th, "On a two-hour trip we usually see one or two of these curious little birds in the low bushes and not infrequently hear the loud notes of others." Again in 1941, we had nine records of its appearance between May 10th and 31st; in other years it was listed on seven, five, four, or two different times.

Usually the northern yellow-throat arrived between May 10th and 15th and could be seen until the end of the month, but in 1944, its arrival was noted on May 4th and in 1942, its latest appearance was on June 13th. As it was first seen on May 11th of that year, it visited the park for a period of over four weeks.

Many people know this attractive masked warbler by its song of "*witchity witchity witchity witch,*" hence call it the "witchity bird." Not only does it give this familiar song in the spring but it continues to sing more or less throughout the early summer.

We did not find this warbler nesting in the park which it might do if the bushes were not kept so well trimmed, but it is known to breed and rear its young not far distant. The site selected for the domicile is on or near the ground and in or near swampy thickets, or among weeds, or in clumps of grass that are near water.

The economic value of the northern yellow-throat is due to its abundance and to its selection of food. It consumes quantities of plant lice, flies and beetles as well as grubs, moths, spiders, ants and larvae of many insects.

Altogether this common, bush-loving or thicket-loving sprightly bird is one of the most welcome visitors in the park. It is often seen in the flowering quince or other bushes near the lake. Curiosity seems to prompt it to hop out and peer at a passer-by with its sharp black eyes which shine through the black mask. The beauty of the plumage is as pleasing to the eye as the cheerful song is to the ear.

Wilson's Warbler *Wilsonia pusilla pusilla* (Wilson)

Length 4.5 inches. Male, above olive-green, crown black, forehead yellow; below yellow. Female similar, with or without a faintly blackish crown.

The small bird called Wilson's warbler is not a common transient in Washington Park; in fact, it is quite an irregular visitor. We have seen it on a total of four trips in three different years. All records were for the middle of May, three of them for a solitary male bird, namely, in 1933, on the 18th, in 1937, on the 15th and in 1941, on the 17th of the month. On May 19, 1941, however, several individuals were seen in tall silver-leaved poplars and in bushes in back yards of a dwelling adjoining the park. We recorded it thus: "The ringing song of this warbler is quite prevalent this morning. An incursion of these birds must have occurred during the past 24 hours."

The absence of wing bars helps to differentiate the Wilson from the female yellow warbler, with which it is sometimes confused. It is said to have a tail-twitching habit at times, with a rotary motion, not up and down as with the palm warbler; this habit, along with the round black cap, helps in field identification. We did not observe this twitching habit but we did hear parts of its song which is something like the *"chip-chip"* of the chipping sparrow.

As we know that this active and energetic little bird does not stay here long, seldom nests in the State, usually does not sing in migration, and is only occasionally found in parks (bushes or trees near the water are its favorite habitats), we are fortunate to get brief glimpses of it during the height of the warbler migration.

"Wilson's black-cap," "black-capped yellow warbler" and "Wilson's flycatcher" are other names of this small warbler.

Figure 46 Formal garden which is centered by the Moses statue and fountain is enjoyed by many people but by few birds. May 15, 1939

FIGURE 47 Bushes trimmed pleasing to the eye but too formally trimmed to attract birds. May 15, 1938

Canada Warbler *Wilsonia canadensis* (Linnaeus)

Length about 5.5 inches. Male, above gray, crown spotted with black; a yellowish line from bill to and around eye; underparts yellow with a distinct necklace of black spots across the breast. Female similar, no black crown, with or without a faint black necklace.

The Canada warbler is probably a more common visitor in the Albany region than is revealed by our notes. As a rule its arrival is between the middle and the end of May so we no doubt missed it when we were not able to continue this study between May 20th and 29th each year. On May 9, 1938, a single male was first heard, then later seen in the tops of tall elms. This is the first seasonal record for the park and a very early record for this territory; another fairly early date was May 12, 1942. We have listed it only 11 times in six different years but we believe that the bird is more consistently present than these records would indicate.

On May 18 and 19, 1936, and May 12 and 13, 1942, a single bird was noted, but in 1938, 1940 and 1941, several individuals were seen on the same morning in different localities; a few were in low bushes and others were in tree tops. This was especially evident on May 20, 1941, when there appeared to have been a definite movement of this species into the park since the preceding day; on this morning we called the Canada common as compared to the numbers of the other ten warblers reported. On "June 1, 1940, the first and only record for this year, a very obvious late warbler movement was apparent and the Canada was observed in the tall elms toward the north side of the park along with many redstarts, a mourning warbler and others"; this was also our latest vernal date for this bird. The oft-repeated cheerful song of the Canada is said by some to be canarylike in quality.

Usually this species does not tarry here long in its migration but in 1938, the year when we had so many early, and also longer, records for other species, our two dates for it in the park were May 9th and 18th. Usually only one or two consecutive dates for its appearance are included in our notes each year, but in 1946, the junior author recorded it on May 14th, 15th and 16th. This wood warbler nests mainly in northern parts of the United States and in Canada and is known to do so in Albany county. Kendeigh (1945, p. 159) recorded breeding birds at Rensselaerville, New York, 30 miles south of Albany and Snyder (1946, p. 5) reported them nesting about 2000 feet up on Mount Greylock, Berkshire county, Massachusetts, which is 40 miles east of Albany.

The Canada is sometimes called "necklaced warbler." Further names which are suggestive of the eating habits are "Canada flycatcher" or "Canadian flycatching warbler." The species is similar to Wilson's warbler in action. An observer derives a pleasurable satisfaction in identifying and watching this alert handsome bird which has a beautiful black necklace on its bright yellow breast.

American Redstart *Setophaga ruticilla* (Linnaeus)

Length about 5 inches. Male, above black; chin, throat and most of breast black; basal portion of all wing and of the tail feathers, except the central pair, orange-red; belly white, tinged with salmon. Female, olive-brown above, white below, with large yellow patches on the wings and tail.

The redstart, another member of the warbler family that is a common summer resident in the county, was observed in the park eight of the first ten years of this study on a total of 26 trips. It was recorded a number of times in 1945-46, and probably would have been listed every year if more field trips had been taken. Our earliest record was May 11, 1936. Next year, we reported its first appearance one day later when a female was seen; the males were not listed until the following day. This is noteworthy, as seldom does the female of any species appear either on the same date or on an earlier one than the male. Between May 12 and 31, 1937, we noticed the redstart on seven mornings, six of which were on seven consecutive (except one) trips between the 12th and 20th of the month. Again from May 15 to June 7, 1941, it was reported on eight trips, with six of these comprising every trip taken between May 15th and 20th.

Usually only a single bird or a pair was seen each morning. On June 1, 1940, however, we noted: "First seasonal record for park this year, and a late one. But several redstarts here this morning, all singing energetically. A marked wave."

This is one of the few warblers which does not acquire adult plumage until the bird has passed the first breeding season after it has hatched. The immature male resembles the female but usually has a few black feathers on the throat or breast. We commented on May 31, 1938, "Markedly less common than usual this season. An immature male singing vociferously in tall elms this a.m., the only one observed." Again on June 3, 1942, "A male in first breeding season seen, not yet in full adult plumage; singing vigorously." This is our latest spring record for the redstart in Washington Park.

On the mornings when this member of the warbler family was present in the park he could generally be heard before he was seen as he was quite generous with his rather weak, but oft-repeated, high-pitched song.

The redstart is so brilliantly colored that one might think it a bird of the tropics; and its vividness, along with that of some of the other warblers, orioles and tanagers, decidedly offsets the repeated claim that our northern birds do not compare in plumage with those of the tropics. Especially is it attractive when seen in a tree full of white blossoms as it nervously darts in and out among the flowers while seeking its insect food, or pauses long enough to utter the characteristic song. It frequently displays the bright colors either by spreading the tail or stretching the wing feathers, or both.

This small, striking "study in orange-red and black" is a welcome spring visitor to Washington Park, where its appearance delights not only bird students but casual strollers as well. It breeds mainly in the Canadian and Transition Zones and is a fairly common nesting bird in Albany county.

Weaver Finches: Family Ploceidae

English Sparrow *Passer domesticus domesticus* (Linnaeus)

Length about 6 inches. Male, above streaked with black and chestnut; crown gray; middle of throat and breast black; sides of throat and belly white. Female, generally grayish brown above and whitish below; no black on throat or breast.

This common permanent resident of the entire Albany region is a descendant of the birds which were introduced into the United States at Brooklyn, New York, in 1850 and 1852. The English, or house sparrow, like the starling, has thrived as an immigrant and has extended its range throughout most of the United States and southern Canada. While this species was seen on every trip during our study in Washington Park, it was not, on the whole, as plentiful as the starling. The increasing numbers of the latter species along with the increase in automobiles and the decrease in number of horses (with their droppings a source of food) in cities is said to account for marked reduction in numbers of the sparrow. Earlier writers as Judd (1907, p. 91) reported the English sparrow as lamentably common in Washington Park and C. A. Reed (1933, p. 88) called these birds "street urchins," probably because they were so frequently seen on town streets. They seem to prefer to stay near habitations either in cities or in the country rather than in the open fields. While these hardy creatures are able to stand the severe northern winters, now and then the cold kills a few individuals, as seemed to be the case with a male picked up in the park on January 8, 1938; it was made into a study skin and bears No. 5985 in the New York State Museum collection.

The pugnaciousness of English sparrows is such that few of the native birds will attempt to live long in the immediate neighborhood with them. Occasionally, however, when a group of small, brownish birds is seen on the ground, the observer at first may assume that all are the common English sparrow but closer examination may reveal other species as chipping or tree sparrows.

The favorite haunts of the English sparrow are about buildings in the park; though often individuals were seen along the shores of the lake and near the fountain in the center of the formal garden, where they were seeking both water and food. Their food is variable depending upon what they can find, as for instance on April 24, 1936 a female was seen busily drinking sap from drillings of yellow-bellied sapsuckers in tall poplars. Then on May 12, 1934 this species was feeding freely on the European larch case-bearer (*Coleophora laricella*) which was very plentiful.

One individual was noticed carrying nest material on March 30, 1938; indications of similar activities on later dates throughout the spring and summer were frequently observed as the species raises two or more broods a year. This bird does not seem to be particular as to the locations of its domiciles, for it may build in such spots as on a branch of a tree, in a natural hollow, as well as in a cavity made by a woodpecker, a bird house, or in crevices or holes in buildings. The nest consists of readily available material as grass, leaves or stems. It may or may not be lined with feathers to receive the four to seven variably marked, brownish spotted eggs, which are deposited between early April and late August.

This species is classed with the weaver birds and is not a true sparrow as its name implies. One author says that the "only sparrow in city streets" may be the field identification of it. As it is also about the only sparrow attracted to feeding stations in the heart of the city, many persons, who enjoy watching birds, provide food for them in their back yards such as table scraps, bread, grain and nuts during the winter months. Others bring food and distribute it in open places in the park. These persons then derive much pleasure from watching the mannerisms of these rather trim creatures in the next few minutes, for that is about as long as the food lasts when a flock eagerly pounces upon it. Despite that hasty consumption of food, sparrows are rather dainty eaters as they often break the bread up into crumbs before eating it, then, oddly, fly to some spot to wipe their beaks on the ground, tree, railing, or any available firm object. Bird feeders also seem to enjoy the sociable, cheerful chirp which this species frequently utters.

Yet other people term the English sparrow a pest because it has a tendency to drive out some of our song birds both by its belligerency and competition for food, and because it consumes grain (especially chicken feed) which is valuable to mankind. In the spring, however, both adults and nestlings feed upon insects, making this bird beneficial to any park as a large percentage of the insects eaten are injurious to trees. This bird is commonly called *either* house or English sparrow.

Blackbirds and Orioles: Family Icteridae

Bobolink *Dolichonyx oryzivorus* (Linnaeus)

Length about 7.5 inches. Male, in spring, black with conspicuous white and buffy patches above. Female, upper parts olive-buff, streaked with blackish; below yellowish buff. Tail feathers sharp-pointed.

This fairly common summer resident in Albany county was recorded as flying over the park during six years of our study from 1935 to 1941, excluding 1936. At no time did we see it on the ground or in the trees.

The first of the total of 11 entries for the bobolink in our notes is as follows: "May 10, 1935, four males, flying not far above trees across west end of park. Flying in northwesterly direction, white patch on back plainly visible and identification certain." Several other times we observed one or several individuals over the park but flying low enough for us to distinguish clearly the notes or calls.

These birds were noted on only one trip in 1937, 1940, 1941, and 1946, while in 1935, we reported them three times, namely, May 11th, 17th and 19th, and in 1938, they were listed on four dates, May 9th, 12th, 13th and 18th. These last mentioned years show a range of eight and nine days in the northwesterly flights of this species over the park. Our first and last spring dates for the bobolink are May 8, 1939 and May 20, 1941.

One can not reasonably expect this species, which usually inhabits grasslands and marshes, to alight or tarry long in a congested city but any observer is pleased to catch a glimpse of the male bobolink in his beautiful and striking spring plumage or to hear his bell-like, musical song as he journeys over the park.

The nest with its four to seven grayish white, darkly marked eggs, which is placed in a depression among the tall grasses of swamps and fields, is rather difficult to find, but the jubilant songs of the male call attention to the breeding area. This is our only songbird that is largely white above and black below, a pattern opposite to that of most birds. This coloration along with his almost unmockable song makes the male quite distinctive in spring, but in the fall his plumage is inconspicuous and quite similar to that of the female.

The common names of "reed-bird" or "rice-bird" have been given the bobolink as it is often found, especially in fall migration, feeding on the seeds of wild oats or reeds and cultivated rice, before flying to South America to spend the winter.

Eastern Red-wing *Agelaius phoeniceus phoeniceus* (Linnaeus)

Length of male about 9 inches; black, except shoulder patches (lesser wing coverts) which are bright red, margined with buffy-yellow. Female smaller, streaked above and below with dusky and white; shoulder patches absent.

The eastern red-wing or red-winged blackbird is a very common resident in Albany county. It is actually not so frequently seen in, as flying over the park. On seven different years of this study we saw from one to four individuals either on the ground or in the tree tops; for example on April 28, 1938, four males were observed together in one elm. Practically every spring we noticed various numbers of them, from one to several hundred flying over the park. Often they flew so low that their characteristic notes were easily heard. This bird ranks 25th on our frequency table as we listed it on 71 mornings in the first ten years of the study.

Our first record for a red-wing in the park was May 11, 1937, when an immature male was heard singing while feeding on the lake's sandy beach. Probably the same individual was recorded the next day at the same spot. Forbush (1927, Vol. II, p. 429) describes the immature male in breeding plumage as "similar to adult male in winter plumage, but dull brownish black, with some pale grayish spots; the bright wing patch usually orange, spotted and barred with black."

Our notes for certain years as summarized show the variability in occurrence of the red-wing over and in this park during spring migration; presumably the greatest movement in number was during early April with not many flocks or individuals being seen by mid-May.

On several occasions in 1938, we noted one or two individuals in the park and also identified others flying over on six dates, while in 1939, red-wings were seen twice in tree tops and 11 times flying over.

Only one adult male was recognized on the ground in 1940, and that was on April 25th; in the same year an immature bird was seen resting in a tree and on nine dates adults were noticed flying over the park in a northwest direction.

On April 3, 1941, we recorded, "Flocks of three, four, 15 or more in the sky, sometimes single birds flying low over trees at frequent intervals; there are both males and females, many of the former are so low that the red and yellow shoulder patches can be discerned without difficulty. All are going in a northerly direction, which may well be a migratory, not a local movement." Our lists for that year show that they were seen flying over on 17 mornings and that single males stopped on two occasions, namely, April 22d (on the ground at edge of lake), and May 16th (in a tree top).

Eight was the greatest number of times that we listed the red-wing in the park in any one year and this was in 1942; we have ten additional dates for them flying over in this same year. On April 4th one loose flock of about 100 was observed in the sky; ten days later another group of 50 or more, plus later stragglers, came over as if from the near-by flyway, the Hudson river. At no time did we see females in the park.

March 24, 1938 and March 26, 1944, were the earliest dates for red-wings seen either over or in the park. Only occasional individuals or small groups make an appearance over the city as late as May 30th. From the latter part of this month on through the summer they are busy in near-by swamps and marshy places with nest construction, incubation of eggs and care of the young.

The male is so rightly named as to be easily identified even in flight and his harsh *"chuck"* note, which is frequently heard, attracts attention, but his striped mate is dull colored with very little reddish color evident on the wing, all of which makes her not only more inconspicuous but harder for an amateur to recognize.

As the favorite haunts of red-wings are marshes, many nesting pairs may be found near Albany and some even inside the city limits. We can not expect to see many individuals in a well-kept city park as their stopping here is only temporary. One may notice numbers of them, however, flying over during migration and hear mainly the *"chut, chuck"* or *"chee-e-e-e-e,"* rather than *"kong-quer ree"* song they give frequently near their marsh homes.

Baltimore Oriole *Icterus galbula* (Linnaeus)

Length 7.5 inches. Male, head, neck, back, wing and tail feathers mainly black; rump, breast, epaulets and outer tail feathers, orange. Female, above olive; rump yellow. Wings in both sexes fuscous with most of the feathers paler edged.

The Baltimore oriole is a common summer resident of Albany county and the cheerful song may be heard practically every morning in Washington Park during the greater part of May. From May 4th, which is our earliest arrival date for 1938, 1942 and 1944, until near end of the month, it is rather common but from then on through June, it is usually observed in reduced numbers. June 7, 17 and 20, 1939, and other summer dates for different years could be given as it nests in the park. As the species was noted on 106 morning trips out of the total of 250 taken from 1933 to 1942, we rank it as 18th of birds common in the park.

The male usually appears a few days in advance of the female. In 1938, one male was first observed on May 4th; and lone individuals of the same sex were reported on each of the eight succeeding trips; not until May 17th were the first females seen. Often in other years the female made her appearance before the middle of the month. On May 18, 1938, we remarked that both sexes were well represented and that the Baltimore oriole was the outstanding species in the park because of its general prevalence, song and striking color. By the last day of the month they were commoner than usual and their rich loud whistle was reported as one of the conspicuous voices heard on each trip.

Their occurrence was quite different in 1939. The usual single first individual was observed on May 6th, but the following note two days later shows a definite change in their numbers: "Several individuals, all males, this a.m. and evidently a marked movement of species has occurred locally in the last 48 hours; warmer weather and southerly winds have prevailed for past two days."

Our attention was often called to an early Baltimore oriole by hearing only the first phrase of the characteristic liquid notes; as we followed this very brief call we could generally locate the solitary male in the top of some tree, often an elm, where his bright plumage was displayed to the best advantage in the morning sunshine. The full song is given not long after the male makes his first appearance and he is in best voice by the middle of May, singing repeatedly and vociferously. The female is dull colored and seldom sings. Great pleasure is derived by either the casual observer or professional ornithologist from hearing the musical refrain or seeing the male bird with his brilliant plumage.

We found a few breeding pairs in Washington Park each year; often the pendulous nest was found adorning a branch of one of the tall elms which are located on the high mound in the central section of the park. These hanging domiciles are a familiar sight in the rural districts also, especially near farm dwellings. People sometimes supply colored threads or yarns in a suitable location and the orioles soon appropriate the material and weave it into their nest.

Vernacular names of "golden robin" and others have been given appropriately to this bird, but the standard name originated because its colors resembled those of Lord Baltimore's coat of arms.

Not only the esthetic but the economic value of the Baltimore oriole is important, as its food is mainly caterpillars, click beetles and their larvae, the verminous and other injurious insects. Trees and other vegetation here benefit by their presence.

Rusty Blackbird *Euphagus carolinus* (Müller)

Length about 9 inches. Male, glossy bluish black in spring; feathers of the upper parts widely edged with rusty color in fall. Female, slate-color and glossy above in spring; in fall similar to the male.

This rather uncommon Albany county visitor was observed in the park only in 1940, 1942 and 1946; neither was the bird seen nor its *"cluck"* note heard from birds flying over in any of the other years of our study.

We were much interested to get our first park record for the rusty blackbird on April 27, 1940, when we saw several birds; one male was in breeding plumage, entirely black and without any rusty color: "Two females were also seen and they apparently were intermediate in color between the typical breeding and winter plumage for they had a slaty-gray general coloration and were marked with a little rusty both above and below. We observed all three birds with 8-power glasses at 50 feet. They and grackles were feeding on the floor of the drained lake and a good comparison could be made between the two species (both of which have white eyes, but differ in size). A few shallow pools remained in this lake bed and here various species congregated to feed, and some of these (the grackles and robins) to collect nest material." On the next day, April 28th, we saw about ten individuals, seven males and three females, and also several grackles looking for food in the same drained area. Their low coarse *"cluck"* and song, combining some of the qualities of those of the red-wing and the grackle, at once drew our attention. These rusties, even though other species were not far distant, maintained their own groups more or less in feeding and in flying to and perching in the near-by trees. One male had lost all his tail feathers. On the following day we noted only one of each sex feeding in the same spot; occasionally both flew to a tree at the south side of the lake where they sang a mixture of low, liquid notes.

On May 1st of the same year several males and females, and on both May 4th and 6th one male and three females were observed in the same drained area in the park; they were at times singing their distinctive notes or preening in trees bordering the near-by dry lake or flying down to feed on the muddy floor which was more or less covered with dead leaves and other debris. Although we watched for them on the next three mornings we neither heard nor saw them.

Not so many individuals nor observation dates were noted for this species in the second year we recorded it in the park. On April 22, 1942, which was our earliest record for the rusty blackbird, one male was seen in a low elm on the north side of the then well-filled lake, and at the same time five males were observed first perched low in an elm on the south side and later down on the ground at the edge of the water; they were not active in either of these locations but just sat and uttered their harsh, low, croaking note. The next day five males were again noticed, possibly the same lot, but this time there was one female with them. On April 24th, 28th and 29th each, only two individuals were seen and heard. Then in 1946, one lone bird flew into the top of a tree near the lake for a very brief visit on April 22d.

Their distinctive notes, when definitely learned by an observer, facilitate ready identification of the birds. Some authorities call the notes unmusical and compare them to the noise made by a rusty hinge.

This blackbird, which is about the size of the red-wing and the cowbird, generally frequents woodland swamps or other wet places, so we were pleasantly surprised to note that they tarried ten and nine days, respectively, in two of the years that we observed them in the city park; it is also interesting that they appeared one year when the lake had been drained and two and six years later when it had the usual amount of water in it; so their appearance occurred here when entirely different physical conditions prevailed.

The rusty blackbird nests from the northern United States through Canada to Alaska.

Bronzed Grackle *Quiscalus quiscula versicolor* Vieillot

Length about 12 inches. Male, black with metallic purplish to bronze reflections. Female similar, but smaller and duller. Tail long and boat-shaped.

The bronzed grackle, which is a very common summer resident, was one of five species reported on every one of our 250 spring trips, 1933 through 1942, and therefore, ranks equal in frequency with the pigeon, robin, starling and English sparrow.

On Sunday morning, March 8, 1942, we noticed from our apartment a male grackle flying back and forth between the white pines along State street and a back yard at Sprague place. Again in the afternoon a single male was seen, probably the same one, near the west end of the lake in another corner of the park. The next morning both a male and a female were noted at the northern side of the park, and this yielded our earliest date for the female in the region. March 6, 1946, proved to be our earliest spring record for the male grackle, not only in Washington Park, but also in the capital district. Another early record for a single male was March 12, 1935. Then only four days later we reported the male of this species as fairly common and that no females were seen. On March 12, 1944, three males were seen in the tall maples near State street and Sprague place. These records, along with others, give the impression that usually one male (sometimes two or three) first appears, then others shortly follow, while the females may not arrive until some days later. The numbers of both sexes increase in late March and early April; also in the first part of April, especially, migrating or moving groups comprising 10 to 30 individuals may be seen flying northward over the city; occasionally a few red-wings are with them and sometimes they fly very high, going directly and without hesitancy in a northerly direction. Many that remain in Washington Park become summer residents and raise their families here. In the fall the females usually disappear first, while a few males have been observed off and on through October 19th.

It is rather difficult in the spring and summer months to say whether there are more bronzed grackles, English sparrows, robins, or starlings in Washington Park, though probably the last named species is most common. Flocks of grackles, sometimes called the "long-tailed blackbird" or "crow blackbird," nesting within this city area have been estimated at 10 to 16 or more pairs in different years. These blackbirds keep well to their colonies in the white pines where most of their nests are constructed and where their chatter can be heard throughout the spring and summer. As these trees are located both on the north and southwest boundaries of the park and are several blocks apart, the birds often fly back and forth between their two local habitations. Here and occasionally in near-by larch trees, year after year, the males establish their territories; whether the same males come back to the same spots we are unable to say as we were unable to band them.

Due to weather conditions as well as to the different dates of arrival of the grackles, nest building and raising of the young took place at diverse periods. One male was seen breaking off small twigs of white pine, as though preparing for nest construction, on March 27, 1936, and other birds on the same date were performing mating antics. An individual was carrying nest material on March 31, 1934, and males were indulging in mating performances soon thereafter; before long the birds were appearing more in pairs and territories were being established; a number of nests were partially completed by April 6th. In 1938, an early warm year, adults were transporting nest material on March 30th; and on April 14th both males and females were still busily engaged in the same occupation, taking mud and damp leaves from the lake floor, and also picking up sticks, dried grass and bits of paper. In 1935, by April 25th, it seemed that nest construction was largely finished and more males than females were in evidence; egg-laying and incubation were probably keeping the females more or less out of sight; both sexes were quieter than usual both in calling and in movements.

In most years, in the first few days of May, adults begin to carry food; soon, egg shells are found here and there under the pines showing that some of the young have hatched. Near the middle of the month, the parents become busier as raucous cries for food are heard from many pine tops; and in general there is considerable commotion among the adults of the rookery. Not long thereafter young may be found on the ground; an unusually early record was on May 19, 1938, when three one-third grown nestlings were observed. We wondered if this could have been the result of intrusion by squirrels, blue jays, or crows as these fledglings were evidently prematurely out of the nest. The young usually leave the nest near the end of May, about the 24th or 25th, or in early June and the adults continue to carry food to them wherever they may be, in the trees or on the ground.

FIGURE 48 Avenue of elms. A rendezvous for warblers. The pendulous nest of a pair of Baltimore orioles often adorns a branch of one of these trees. April 23, 1938

FIGURE 49 Kinglets, thrushes and white-throated sparrows hide and rest in bushy clumps like these. May 14, 1941

Figure 50 Spruces and other trees located off Englewood place, in the spring provide shelter and protection for chipping and white-throated sparrows. October 10, 1941

Figure 51 These groups of larches on either side of road leading up from the lake serve as resting and feeding trees for many birds. October 10, 1938

On June 2, 1941, we noted a male feeding well-grown young high up on a limb of a larch tree. Many young are out of the nest by this date in June; their early morning food calls vie in loudness with those of the more numerous young starlings with whom they often associate. The cries of these immatures along with voices of their excited parents provide a strident chorus of bird notes. Even as late as June 13, in 1942, we recorded young of the year well able to fly but still attended by adults to some extent. The young and old grackle population of the park is at its height by the middle of June, the immatures continuing to attract attention by their persistent food calls.

As there are many automobiles passing over the park roads, it is not surprising that birds, especially young of the year, become victims of the motor cars; we had an example of this when we found the remains of a badly crushed juvenal grackle on one of the cement roads on June 20, 1938.

The conspicuous long tail, of a little over five inches as compared to the 2.5 inch tail of the starling, helps to differentiate these two black birds.

Among all the grackles that we saw during this study only two partial albinos were noted. One immature bronzed grackle seen on June 7, 1940, which was able to fly, had two or three white rectrices; the contrast in color in these tail feathers was plainly visible. The other individual was noticed on May 7, 1941; this adult female had pure white rectrices, along with a thin white crescentic wing patch and a delicate white line around back of neck. The bird was seen at close range on the ground and appeared to be in good condition.

Grackles are well able to protect themselves against the intrusion of other birds; they not only chase robins and other birds away but have been known to destroy eggs and young of other species; as the food of the young is mainly insects, however, the grackles are, on the whole, beneficial. They also afford much pleasure to the many visitors of this popular park in the spring who take time to watch these handsome creatures that are walking about rather sedately with long strides over the ground, or building their bulky nests which later may contain three to seven speckled eggs, or seeing the parents feed the young, especially those that are out of the nest.

Eastern Cowbird *Molothrus ater ater* (Boddaert)

Length about 7.5 inches. Male, black except for the brown head and neck. Female uniformly dark brownish gray.

The cowbird, a dark colored bird known sometimes as the "cow blackbird" or "cow bunting," is a common summer resident in the Albany district. It was seen in Washington Park every spring, on a total of 148 mornings out of 250 trips during the years 1933-42, and, therefore, ranks ninth on our frequency of occurrence record.

Our earliest record for the cowbird in this city area is April 13, 1936, considerably later than the grackle's first appearance but about the same time that the greatest number of red-wings are seen flying over. It is also later than some of our district annual records of cowbirds, one of which was the very early spring date of March 14, 1941. We then saw eight males and two females, along with about 15 horned larks. They were all feeding on a small expanse of manure, which had recently been distributed in an open field that adjoined a main Rensselaer county highway about nine miles southwest of Albany. This district record is given to illustrate how much later the cowbird is first seen in the park. Mention is made also of grackle and red-wing arrivals as cowbirds often flock with both of these species during migration. June 13, 1942 is our latest park date for the cowbird and neither on the all-day field trip of July 26th of the same year, nor on any other summer or fall day, did we again observe the species here.

While the female is dull in color, the metallic bluish and greenish black body plumage and brown head and neck of the male are glossy and really beautiful when seen in the sunlight. One can not but admire the appearance of this trim small blackbird but at the same time, conscious of its parasitic habit, one wonders what species will serve as a foster parent for its egg and young. The cowbird builds no nest but lays its egg in those of other species. Usually the eggs are deposited early in the morning when the foster parents are absent and often in a nest which already contains one or more eggs of the rightful owner. Nests both high in trees and low on the ground are entered and generally are those of birds of small, rather than large, size. Frequently several cowbirds of both sexes appear together in the park. On a few occasions we noticed only one male, while on four mornings two males and one female were listed; on only one date did we see a reverse grouping. In 1938, cowbirds were fairly common and we observed them on 20 of the 34 trips. More were seen from April 14th to May 12th, but from then on until June 3d smaller numbers were observed on fewer mornings; in summing up the counts for the different years of this study, the greatest number of individuals was recorded in the park during that spring of 1938. Our records note the cowbird as present on 22, 20, 28 and 28 trips respectively, in the next four consecutive years.

Tops of trees as the larch, elm, maple, ginkgo and pine were favorite perches for both sexes. A lone male often sat high up in the very tip of a pine near the larches south of the lake; at other times a male was seen at the very top of a tall ginkgo on a high knoll near Englewood place. Each appeared as if he might be serving guard duty; however, neither bird remained silent but uttered a hoarse *"kluck-tse-e-e"* frequently. When both sexes were present in the same tree top, the male might be seen raising his wings and performing other antics of cowbird courtship as he gave his queer, harsh song.

In looking over our records it is noticeable that distinctly more males than females were seen in Washington Park. Perhaps as Hann (1937) says, the reason for this may be that the female is skulking about looking for nests where she can lay her eggs. Not only is she known to seek out these nests for egg-laying but she also is known to take eggs of the host out of the nest.

Friedmann (1929, p. 196) mentions the red-eyed vireo and the chipping sparrow as two of the five birds frequently parasitized by the cowbird in New York State. Rarely are grackles, starlings, or English sparrows victimized, as their pugnacious temperaments serve them well in protecting their domiciles. During this study we have seen no cowbird eggs in the park but think it likely that some may have been laid as there were many adults present during the proper period. Especially were they noticed near chipping sparrow nests and we suspect that red-eyed and warbling vireos may also have been their victims.

In the Oneida lake region we found cowbird eggs in several yellow warblers' nests; we saw a young cowbird in a nest with four young black-throated green warblers; another in a nest with three young song sparrows; and found on the ground a juvenal, too young to fly, but well attended and fed by a pair of oven-birds. We also found the cowbird parasitizing four other species in this region, namely the redstart, robin, veery and wood pewee. Friedmann (1929) listed more than 200 species that these birds have used as foster parents and in 1931, he recorded a substantial additional number.

About ten miles south of the park district, on June 7, 1939, we found a nest in a clump of goldenrod (*Solidago rugosa*) six inches above the ground in a cleared area near a hemlock and mixed woodland area that contained two eggs of the yellow warbler and one of the cowbird. On June 16, the foster parent's two eggs were still there along with a cowbird, four to six hours old; this nestling had a temperature of 97.8° and weight of 3.5 grams. Two days later, the two young warblers averaged temperatures of 102.0° and weights of 3 grams, as compared to the parasite bird's 104.4° and 13.2 grams. On June 21, temperatures of all were about 107.0° and the weights of the two warblers and cowbird were 6 and 23 grams, respectively. On June 23, the last day before nest and contents were destroyed by a truck, the warblers averaged only 104.0° in temperature and 8 grams in weight, while the cowbird's figures were 106.8° and 29.5 grams. This shows a rapid gain in weight of the young cowbird as compared with that of the young of the foster parents.

The incubation period of cowbird eggs is about ten days which is shorter than that of most species. Thus the nestling cowbird which has hatched earlier than the other occupants of the nest is older, larger and stronger and gets most of the food from the adults. As it grows still stronger it often crowds out the rightful fledglings, which then perish. To the extent that this happens, the cowbird is injurious; however, the adults are beneficial in feeding on weed seeds.

Soon after the immature cowbirds are able to procure their own food they find others of their own kind and flock with them, deserting their foster parents. In late summer and during migration they associate with flocks of other blackbirds as grackles, red-wings and starlings.

This bird derives its common name from its habit of following cattle.

Tanagers: Family Thraupidae

Scarlet Tanager *Piranga olivacea* (Gmelin)

Length about 7 inches. Male, wings and tail black; general coloration in summer bright scarlet, in winter similar to that of the female. Female, wings dusky; above olive-green; below yellowish green.

The scarlet tanager, a fairly common summer resident of Albany county, was recorded 17 times in eight of the first ten years of our observations in Washington Park, between the inclusive dates of May 4th (1942) and May 30th (1940). We did not hear nor see the bird in 1934 and 1935. It was listed only once in five different years, twice in 1937, thrice in 1941 and seven times in 1942. In many years the scarlet tanager is first recorded in the park between May 11th and 20th. On May 4, 1942, which was also our earliest seasonal date for the region, one male was noted singing volubly and persistently in the top of a high elm on the north side of the lake; a single male was observed here on the next two succeeding days; perhaps it was the same bird. In that year we noted this species on seven of 12 trips taken within 15 days.

Another early record was May 5, 1944, when we heard the scarlet tanager first; then, as we did with many other species, we followed the voice and located the singing individual, perched in the bright sunshine at the top of a tall tree some two blocks distant. One's esthetic sense is aroused by the sight of this feathered creature which is so rightly named scarlet tanager; his bright plumage makes him quite conspicuous among the green foliage of any tree and produces a picture that will long hang on the wall of memory of the observer.

Usually only one or two males were seen on a trip but on May 19, 1939, two birds of this sex and one female were listed. One individual in the first breeding plumage along with a mature male were studied on May 14, 1941; the yearling had yellowish green instead of scarlet underparts. Both birds were singing in characteristic fashion.

The scarlet tanager occasionally moves to different trees while uttering its rasping, robinlike notes. So loudly is its song given that it could be heard through the open window of our apartment, across the street from the park. When a bird student once learns that the song is similar to, but deeper and hoarser than that of either the robin or the rose-breasted grosbeak, he can readily recognize it.

The adult male is easily identified in the spring as it is the only bright red bird with black wings and tail; but in fall, in changing plumage, it appears more or less patched or spotted in scarlet, yellowish and green.

The breeding range is given by Chapman (1932, p. 495) as mainly in the Transition and Upper Austral Zones which include the New York capital district. We noted an increase in their numbers in our Albany county records for the summers of 1941 and 1942. The species seemed to be holding its own in the 1946 season for not only was it recorded in the park on four mornings (both sexes seen on two of these and two males on another) but there were numerous records of both sexes for near-by country districts; in one location, 12 miles from the city, the junior author saw three males together on May 18th; in another locality on the same date two females and one male were observed for some time in high trees.

The colorful tropical plumage and beneficial insectivorous habits make the scarlet tanager a desirable inhabitant anywhere. The advantage of a large city park in learning to know birds is emphasized by the possibility of seeing these colorful creatures during their brief spring visits. Either an amateur or a professional ornithologist regards it is a red-letter day when he has seen a male scarlet tanager.

Grosbeaks, Finches, Sparrows: Family Fringillidae

Rose-breasted Grosbeak *Pheucticus ludovicianus* (Linnaeus)

Length about 8 inches. Male, black and white with triangular, rose-red breast patch and under wing coverts pink. Female, grayish brown with white line above eye and white wing bars; underparts buffy, streaked by dusky; wing lining yellow.

This fairly common resident of Albany county was reported practically every year as a May visitor in Washington Park. It was not, however, seen on many occasions nor in numbers. As a rule, a solitary male was observed.

While we listed the rose-breasted grosbeak a total of 24 times during the 1933-42 study, half of these records were in 1938 and 1941. In the first of these years, their stay was for about eight consecutive days, records being for May 11th, 12th, 13th, 14th, 18th and 19th. In 1941, their visit extended over a period of practically two weeks, as vouched for by observations on May 7th, 9th, 10th, 15th, 19th and 20th. This series included our earliest and latest date for the bird in the park; May 7th is also an early seasonal date for the region. The dull, grayish brown female was observed on May 15 and 20, 1941 and May 13, 1942. In 1946, both sexes were seen on three of the five dates of their appearance between May 12th and 20th. Quite often a lone male was heard vocalizing freely before he was seen.

This conspicuously black and white bird, with a bright rose-red, triangular breast spot is usually perched high in the tree tops. Here on a sunny morning the observers could enjoy not only seeing his beautiful plumage but also listening to his happy song, which somewhat resembles that of the robin or scarlet tanager. We noted that his melody is more musical and continuous than that of the latter bird; he repeats the phrases quite often and gives the song as if he himself enjoyed it and did not like to stop.

Noxious insects, weed seeds and wild fruit make up a greater share of the food of this useful and beautiful species, which is really more a bird of woodlands than of city parks. Nests where young were successfully reared have been reported two and six miles from the park.

Indigo Bunting *Passerina cyanea* (Linnaeus)

Length 5.5 inches. Male, in summer, rich blue, with darker shadings on head and wing and tail margins; in winter similar to female. Female, grayish brown, unstreaked; tail, wings and rump faintly edged with bluish; breast whitish, tinged on sides with brownish.

The indigo bunting, a fairly common summer county resident, is seen sparingly in Washington Park. We observed it on only 11 trips during 1935, 1937, 1938, 1939 and 1942, all between the 11th and 19th of May.

Two males, "indigo birds," as they are sometimes called, were first seen on May 11, 1935, in one of the larch trees south of the lake. This is not only our first park record but is also a fairly early seasonal date for the region. Four days later, four individuals of the same sex were observed at the same spot and a female was detected in an adjacent tree; this is our only record for a female in the park. One male was listed on the following morning, while on May 19th we recorded that the bird had been more than usually common here this spring. Again in 1937, on four mornings between May 16th and 19th, we listed this brightly colored species; on the first date, there were three males.

We saw the indigo bunting on only one morning each in the next two years and afterward did not record it until May 16, 1942, when again it was seen on only one morning. It was becoming increasingly common in the county, however, as stated in the following field notation by the senior author in *Feathers* (1943, p. 13-14):

> "The widespread prevalence and abundance of this bird in the Albany area during the summer of 1942 is worthy of comment. Not, in the ten years of my bird observation here, has this bunting occurred in such numbers. From every shrubby thicket, fence row, wooded tract and roadside its loud, distinctive song gave notice of its presence.
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> "Just what was accountable for the increased abundance in 1942 one cannot know. Possibly the war situation may be directly or indirectly associated therewith. Obviously, with few persons tramping the woods and countryside and the ever-mounting acreage of reverted land, breeding conditions for this bunting have become more satisfying. The unwonted freedom from disturbance during the nesting period coupled with the increased vegetational growth of appropriate character may have been accountable for the more general prevalence and evident breeding success of the species in the area."

Thus, a species may be very common in the immediate vicinity of the city and yet may be seldom seen in Washington Park. The growth in the park is not suitable as a nesting habitation for this trim-looking creature of tropical colors; the beautiful blue of the male bunting is rightly described as indigo.

The cheerful and rather emphatic song is given not only during migrating time but throughout much of the hot summer. Often this loud songster is heard before the individual is seen; a high point in a tree usually is selected from which to pour forth his melody. Here he warbles happily on and on, for not only is the phrase prolonged but it is repeated over and over.

Authorities state that grasshoppers and other insects form the principal diet during the summer. This indicates the economic value of the indigo bunting, while its esthetic worth is evident to the many who enjoy hearing its musical song and seeing its brilliant blue plumage.

Eastern Evening Grosbeak

Hesperiphona vespertina vespertina (Cooper)

Length about 8 inches. Bill large, conical and yellowish. Male, olive-brown in general coloration with yellow forehead; and the crown, as well as the tail and wings except white-tipped secondaries, black. Female, duller without striking head and wing colors; general coloration brownish, faintly yellow on nape.

On only one occasion did we see this erratic winter visitant in Washington Park. On March 14, 1942, our attention was first drawn to a single male by hearing his notes from the larches near the west end of the lake. We had no sooner located him high up in one of these trees than he flew 100 feet to the top of an elm. Here he remained long enough for us to obtain a fair view, while he again uttered his characteristic note several times before flying away over the city. This was probably a straggler from a near-by flock as this species had been reported at various times during the winter in the Albany district. It was also a more frequent visitor to the surrounding area in the previous winter (1941-42).

The evening grosbeak is so irregular in appearance that our getting only one park record is not too surprising. The number of birds seen in a suitable habitat may vary from one to 40 or more. Other Albany or near-by visits are mentioned as they tell something of the habits of this peculiar but beautiful grosbeak.

The authors had ample opportunity to study the evening grosbeak on February 11, 1934, at the home of Joseph Gavit, 69 South Pine avenue, less than a mile west of the park. Here a flock of 20 (11 males and nine females) were feasting on seeds of box elder (*Acer Negundo*); at intervals they flew to a near-by house roof and, after resting momentarily, returned to trees to feed. During this time a weak, coarse note was occasionally uttered. Although this was their first appearance here that year, according to Mr and Mrs Gavit they had fed in the same trees in several previous winters.

Between January 15 and May 13, 1940, a flock of nine to 30 evening grosbeaks visited the Emma Willard campus at Troy, New York; this is about eight miles northeast of Washington Park. No doubt one of the reasons for their daily visits for several months on the campus was the bait of sunflower and other seeds which were scattered every day in the same spot. Some of the individuals became quite tame and would occasionally alight on a ledge just outside one of the windows of the dormitory, where food was placed. A couple even ventured through the open window and flew a few feet inside the room to the top of a dressing table, where they paused long enough to partake of the seeds in a saucer. Their behavior during a protracted stay on the campus was a most gratifying response to friendly treatment.

For another instance, within the boundaries of Delmar, New York, about five miles southeast of Washington Park, three to nine individuals were observed between early December 1943 and late April 1944. Here they fed on seeds and buds in the trees and on the food provided them by bird enthusiasts. Other records could be cited of their appearance in and near Albany so we may have missed seeing birds visiting the park during our study period. This is a species which has extended its eastward wanderings as Judd (1907) does not even report its occurrence in Albany county. Eaton (1914) gives only two records, both from Troy, New York, for 1890, and none for Albany. In more recent years, however, other observers have reported it. The many plantings of the box elders and other seed-bearing plants in eastern states is said by authorities to be one of the reasons for more numerous recent occurrences of the species.

These unsuspicious and conspicuous birds attract attention to themselves by their beautiful plumage and by the irregularities of their visits. They were first named evening grosbeak because it was then thought that they sang only in evening; now it is well-known that their song is given throughout the day. They are sometimes called "English parrots."

Eastern Purple Finch

Carpodacus purpureus purpureus (Gmelin)

Length about 6 inches. Male, rosy-red; wings and tail brownish; belly whitish. Female and immature males, sparrowlike in color with white streak above the eye. Tail slightly forked.

This common, transient visitor was present in the park every year between 1934 and 1946 for various periods. The earliest date was April 8, 1941 and the latest, June 17, 1939.

Usually the bird was first observed on April 11th or 12th and seldom did we list it after May 20th. In fact, only two later dates, both in June, are recorded in our notes; these were the above mentioned late record in 1939 and June 7, 1941. On both occasions a single individual was heard singing.

During the first ten years of our study, the purple finch was recorded on 100 field trips. It, therefore, ranks 19th on the list of the 50 commonest birds in Washington Park. Frequently we heard the melodious song long before the performer could be located.

The handsome, male bird, perching erectly, singing in the tree tops is not a sight nor a sound to be ignored by the bird student. His rosy-red (or Tyrian purple) plumage attracts attention as it is so colorful in contrast to the dull-brownish, streaked garb of the female. The young males, until about fifteen months old, resemble the female and are therefore a little more difficult to recognize; if a sparrowlike bird, however, of upright posture as it sits in a tree top, bursts forth into song, its sex is evident as the female sings little. In 1934 and 1935, no full-plumaged males were seen.

On April 21, 1938, between 15 and 25 individuals were seen in the park. On many of our trips one to four was the number heard or seen, and usually the early arrivals were of streaked plumage, thus being females or immature males.

On 24 of our 40 early morning trips in 1941, the purple finch was listed. Only one individual was heard on the first seasonal date of April 8th; then two birds of streaked plumage were seen and heard singing volubly on the 14th; while on the following day three or more in the same plumage were heard and observed. Not until April 18th, did we see males (two in number) in "high," purple plumage. A flock of six to eight and scattered individuals also were seen on the same morning. Our notes for April 21st are: "Heard singing everywhere; adults of both sexes and immature males were present. Larch trees in particular seem to attract them now. The purple finch is commoner in the park this season than any time during our period of observation. We encountered more than 50 individuals this a.m." By June 7th, only one bird was singing persistently; the melody seemed somewhat like that of the warbling vireo. The purple finch was reported to be unusually common in near-by localities that year, which may account for the more numerous park records.

The first record for the season of 1944 was on May 2d when four purple males were admired by us as they rested in the larches on the south side of the lake. This was an unusually late date for their first park appearance. We had fewer records for this year, as well as for the earlier years of 1934 and 1937, but again there were many records in 1945 and 1946.

In most years the purple finch appears to reach its peak of abundance here by late April and by the middle of May its numbers have decreased to a very few. During this period, no doubt, insect pests of elms, maples and other trees along with some buds and blossoms are consumed as food. The species breeds sparingly in the Albany region; its song is occasionally heard not only during early summer but also in winter when usually a few individuals remain.

The oft-repeated, warbling song which is so distinct and melodious in the morning avian chorus, as well as the attractive plumage and the erratic seasonal appearance of the purple finch, all tend to make it one of the most welcome and noticeable of the bird visitors of Washington Park.

Northern Pine Siskin *Spinus pinus pinus* (Wilson)

Length 5 inches. General coloration, streaked grayish brown; base of tail except middle pair of feathers, and base of wing feathers yellowish; two white wing bars.

In Albany county the pine siskin is an erratic winter visitor; it was noted only in two different years in the park, namely in 1939 and 1941.

On May 29, 1939, we observed several pine siskins in the tops of tall larches on the north side of the lake. They maintained a continuous low chatter as they fed. At times fluttering in the tree tops, they exposed to view the yellowish green markings in wings and tail. Although this is our first record for the park, it is not at all unlikely that the bird had been overlooked previously. It is irregular in occurrence, however, and this is a late spring date for the region.

About two years later, one bird was seen in the same place. On this date of April 18, 1941, we viewed it for several minutes; its peculiar low whistle had first attracted our attention. On the following day, six individuals were associated with goldfinches in the same group of trees; all were busily feeding on the larch buds. Then on succeeding days we saw from one to several individuals feeding in the same conifers with either purple finches or goldfinches and, on one occasion, with seven red crossbills. Our following notes for April 25th again emphasize the increase in numbers, along with their habit of associating with other related birds: "A flock of 15 or more were in the larches with goldfinches, red crossbills and a few purple finches. They were uttering a sharp high-pitched note something like that of the goldfinch as they fed on larch buds and cones while perched or hanging suspended at all angles. This bird is much more than usually prevalent this season."

Within a week they were seen on four mornings with goldfinches and crossbills in increasing numbers; they also continued to be quite acrobatic in their movements. While loosely associated with other birds, they remained together when feeding, the entire group of siskins working at a lower level in the tree than the crossbills which were feeding in the same larch tree. The contented, metallic, sweet chatter was uttered almost continuously. On April 29th, we remarked that this chatter of 15 to 20 pine siskins was a conspicuous feature of the bird life in the park this month. This winter visitor was still here on the following day, according to our note: "If anything, the species is even more abundant. We feel safe in stating that well over 25 individuals were observed this morning in the three principal larch stands that are north, south and west of the lake." Three days later 25 or more birds were in one group of larches. At intervals they were participating in group flights, or in acrobatics and gymnastics, and vocalizing as they fed.

Only a few individuals were seen on May 5th. Our last record was for May 6th, when six birds were identified in tops of tall silver-leaved poplars which was a new stand for them. The pine siskins were observed in Washington Park over a period of nearly three weeks, on a total of 14 trips in 1941.

The unusual prevalence and abundance of this species here that year is of more than passing ornithological interest.

Eastern Goldfinch *Spinus tristis tristis* (Linnaeus)

Length about 5 inches. Male in summer, canary-yellow; crown black; wing and tail black marked with white; in winter, similar in color to female except wings black. Female, olive-yellow with blackish wings and tail marked with white.

The eastern goldfinch formerly designated as the "American goldfinch" is a familiar resident of Albany county; it was observed in the park every year; in fact it was one of the commonest birds, ranking

12th on our list of the 50 species most frequently observed during the first ten years of study. While the species is in this region the year round, it is present in reduced numbers in the winter.

During the spring molting, males may occasionally be seen with some dark and yellow feathers. We noted in our earliest park record of three birds seen on April 8, 1941, that the prenuptial molt was not complete. Yet a male recorded only ten days later was in full breeding plumage of bright yellow. In 1938, several individuals in partial winter dress were first observed about April 20th. Then in 1942, of the several birds first seen on April 22d, one was in nearly full breeding plumage; a few were in summer garb on May 2, 1936, which was the first date for that year. As late as May 9, 1940, we noted that complete breeding plumage was not yet attained. On May 12, .1939, the males were resplendent in bright yellow and black. These records emphasize the variable time for molting and for their appearance in the city area. Goldfinches were usually seen through May 20th; a few June dates are listed as well as a record in mid-summer, July 26, 1942, and in fall, September 1943. The birds which were more common in some years than in others, varied from three to four up to 50 or more individuals in each flock.

The larch trees seemed to be most attractive to them as we noted on April 23, 1941, "More common than usual in the park this season, frequent larches where they busily feed on buds and the associated insects in company with purple finches, pine siskins, chipping sparrows and a flock of red crossbills." Previous record of their food habits is given thus on May 12, 1935, "Larches in park just now heavily infested with larvae of the European case-bearer (*Coleophora larvicella*). Goldfinches feeding freely on the larvae, also English, white-throated and chipping sparrows, vireos and warblers. The concentration of the goldfinches on the larches now is, however, particularly noticeable." On other dates these birds were observed with the ruby-crowned kinglets while hunting for food in the same group of trees. This species, which is quite gregarious, also frequented the poplars and other trees at different times.

As the goldfinch consumes insects in spring and noxious weed seeds in midsummer it is a beneficial species. The strong cone-shaped beak splits the seeds so that the bird may consume the nourishment inside the husk. While feeding, it is somewhat acrobatic sometimes hanging upside down upon weed or tree branches. Not only is this brilliantly colored bird pleasing to the eye but it has a beautiful, warbling melody when it is in full song in late April or throughout May and early summer. This warble is likened to that of a caged canary. The dainty little *"ba bee' ba bee'"* repeated rapidly in a soft, happy and cheerful tone can be heard as a flock rises in undulate flight, or the contented chatter is plainly audible as they feed on seeds of various kinds. At no time does its call seem sad as the specific name, *"tristis,"* implies. Some interpret the call note as plaintive and like crying.

In conversation with Mr E. J. Palmer, park commissioner, he used the word "shiner" in reference to this bird. Evidently this is a colloquial term in the Albany territory for the goldfinch in its shining, yellow and black plumage. Judd (1907, p. 89) also referred to this regional name. "Wild canary," "yellow bird" and "thistle bird," are other well-known common names for this species.

Although this yellow and black bird visits the park fairly early in the spring and nests not far distant in the country, it is one of the latest of the feathered tribe to build its domicile. As May (1939, p. 498) says, "The goldfinch delays its nest-building until the seeds of weeds begin to ripen and until it can find thistledown with which almost universally it lines its nest. Often the nest is not built until July or August and young birds recently fledged are not uncommon in September."

Red Crossbill *Loxia curvirostra minor* (Brehm)

Length about 6 inches. Elongate, sharply pointed mandibles crossed when closed. Male, brick red; brighter on head, breast and rump; wings and tail darker. Female, grayish olive streaked with dusky; yellowish on breast and rump; wings and tail dusky.

This uncommon, erratic winter visitor was seen in Washington Park only in the year of 1941, when it was observed in varied numbers between March 30th and May 9th on 16 different mornings.

As the appearance of the red crossbill in this city area was so unusual and of such ornithological interest, the dates and number of birds seen are given in detail:

Date	*Number*	*Date*	*Number*	*Date*	*Number*
March 30	3	April 26	15	May 3	15 to 20
April 7	1	April 28	20 to 25	May 6	4
April 21	6	April 29	20 to 24	May 7	2
April 22	5	April 30	30+	May 9	22
April 23	7	May 1	25+		
April 25	15	May 2	15+		

FIGURE 52 Dayton Stoner observing a bird in the larch trees at the north end of the park. Lilac bushes and white pines on right. Photo by Lillian C. Stoner. May 16, 1941

On the first occasion one female and two males were definitely identified by an ornithological student on an early morning trip in the park. On April 7th, a male was observed at close range by the senior author who noted: "My attention was first attracted to the bird by its low, coarse note, one with which I was unfamiliar. Followed the bird for about 30 yards and it alighted on the very top of a tall slender tree 40 feet up, where I studied it for ten minutes in the brilliant early morning sunshine. The general coloration was distinctly reddish with rump bright red."

No crossbills were reported for two weeks. Then, on April 21st, a flock of six were seen first in the tall conifers at the west edge of the park; later, two of each sex were located in the near-by larch trees, where they were busily feeding with purple finches but were uttering no notes. On the following day the grayish plumage of three females and the reddish coat of two males were plainly visible to us as we stood only 20 feet distant; here we had ample opportunity to watch them as they fed contentedly and unaffectedly again in the larches near the west end of the lake. From this spot they flew first to near-by elms; fifteen minutes later, the same flock was with goldfinches and purple finches about a block farther east in the tall tamaracks. The crossbills, for the most part, fed close together and if one individual flew to another tree, the remainder of the flock was likely to follow immediately.

On April 25th, two groups were seen in separate locations in the park, but they really comprised a single flock, temporarily divided while the members were feeding. These birds appeared to remain more or less aloof from the siskins, goldfinches and purple finches feeding in the same trees, the crossbills feeding higher up and remaining pretty well together. Occasionally they were seen picking the cones or buds on the ground below the larches. The proportion of sexes in the flock seemed to be about three females or immature birds to one full plumaged male.

Near the end of April the number of crossbills in the park had been augmented considerably, and although more numerous, they still kept more or less together and did not disperse as loosely as the goldfinches and siskins. Suddenly following an alarm note uttered by a member of the group, they would all arise in unison and in close formation and while uttering a series of low sharp *"chips"* (a noise somewhat similar to that of young chickens) they would fly across the lake or take a circuitous route and return to or near the tree they had just left.

The greatest number of individuals (namely, 30) was recorded on April 30th. At this time the birds appeared restless; local concerted movements were frequent and the chirping males more evident. This restlessness was even more pronounced in the next few days as they flew about frequently. They were feeding on elm seeds which were at or near the height of seasonal production and probably on some of the attendant insects, as they are said to eat gall insects, plant lice and other insects.

No crossbills could be found in the park on May 5th, and only four and two were located on the two succeeding days. On May 9th, however, the last day they were observed, a flock of 22 individuals flew over the lake uttering the characteristic harsh *"chip"* notes; the close formation in flight was plainly apparent. Their visit here had extended over a period of 40 days.

The common name, red crossbill, aptly describes this beautiful bird's general coloration and peculiar physical feature; the latter seems not to interfere with its seed eating habit as they first use the crooked curved bill to break up part of the cone and then the tongue to pick up the seeds. Chapman (1932, p. 517) says, "These parrot-like finches are famous for their erratic wanderings. They seem to have no regard for the laws of migration which regulate the journeys of most birds, and having no home ties may linger in regions which offer them abundant fare without much regard to season." They journey in winter south to northern Texas, Louisiana and Florida and sometimes even to Bermuda.

One of the notable ornithological features in Washington Park in the season of 1941 was the unusual and consistent prevalence of red crossbills, pine siskins, goldfinches and to some extent purple finches, and their more than casual associations.

Red-eyed Towhee

Pipilo erythrophthalmus erythrophthalmus (Linnaeus)

Length about 8.25 inches. Iris red. Male with upper parts, throat and breast black; belly white; sides and flanks rufous-red; conspicuous white on black tail and wings. Female, duller with grayish brown in place of black.

The red-eyed towhee, a common summer resident of Albany county, makes brief and few visits in Washington Park during the vernal season. While the bird was observed here in eight of the first ten year study period, between April 27 (1938) and May 18 (1937), it was not listed on many mornings. Only one male was recorded a trip except on one occasion when two of the same sex were heard and seen as they sang energetically, May 12, 1941.

In fact the red-eyed towhee was noticed only 13 times on the first 250 study trips and all dates except one were during the first half of May. This is not surprising since their habitat is usually in shrubby thickets along edges of woods or clearings, in other words in places where the undergrowth affords them good cover. A city park where the leaves are raked from beneath well-trimmed bushes and shrubs, is not sufficiently attractive and protective to lure many individuals of this shy species.

On the bird's few visits here, it was observed in three different sections, always on the ground or in low shrubbery. On May 5, 1934, it was noticed immediately north of the midsection of the lake; this spot is only 200 feet from Madison avenue car lines and their accompanying noise and yet the male bird could be heard uttering its call frequently. At another time the towhee was seen across the lake from the previously mentioned place, where he kept well-concealed in the small thicket of flowering quinces which adorn this sloping hillside. Several times the species was seen scratching among leaves on the ground in the back yards just off Thurlow terrace and adjoining the park, where vegetation was allowed to grow unmolested and luxuriantly for most of the years of this study. The feet of the towhee are used in this vigorous scratching for food, leaves are scattered and considerable noise and disturbance is made for a bird of this size.

Because of its terrestrial habits, the common name of "ground robin" is applicable although the bird is smaller than the well-known lawn robin. As the iris is red and the call sounds like "tow hee," it is rightly named red-eyed towhee; often also it is equally well-named "chewink" from another repeated brisk call. Throughout most of the spring and summer both of these notes may be heard not far from the city line, in bushy areas that afford suitable habitats for nesting. We have found the nest on the ground in the Karner cut-over section about seven miles from Albany. Perhaps another reason for their choice of this location is the abundance of blueberries. McAtee (1926, p. 64) states, "About three-tenths of the food is animal matter and seven-tenths vegetable. Of the latter portion seeds, mast and wild fruits are the important items."

The cheerful song which some liken to the phrase "drink your tea" and the striking appearance of the male, along with the habit of consuming many forest insects, make the towhee an interesting and welcome visitor.

Common Slate-colored Junco

Junco hyemalis hyemalis (Linnaeus)

Length 6.25 inches. Male, upper parts and breast slate-gray; belly and outer tail feathers white. Female, duller and lighter.

In Albany county, the junco is a common winter visitor; it was observed every year in the park during the first decade of this study between the inclusive dates of March 24 (1938) and May 18 (1938); however, several birds were seen on the earlier date of March 18th in 1945. As the junco is in this region during the fall and winter, still earlier occurrences in the park are probable. The species was reported to be a fairly regular attendant at several winter feeding stations in the city. It is 22d on our 1933-42 list of common birds in Washington Park and probably was most abundant during the spring of 1941, when we listed it on 16 of the 41 trips.

Juncos occur here in numbers varying from one to a flock of 50 or more individuals. Their slate-gray plumage blends so well with the dead leaves on the ground where they often feed that an observer has difficulty in locating the birds but as soon as they fly up, the white, outer tail feathers are plainly visible and the movements of the birds can be followed by means of this very definite field character. Then, too, either the cheerful *"tsip"* note or a musical chatter softly voiced may announce their presence. The birds were observed in different sections of the park either low or high in various shrubs or trees or on the ground along the roadways which had been closed to the winter motor traffic; in these latter places they were also less disturbed by pedestrians. When large numbers were present, they remained in a loose flock, flying from low branches of shrubbery to trees or to the ground and back again. They were more prevalent in larger groups about mid-April or shortly thereafter, as recorded in the following field notes by the senior author:

> "April 16, 1936. Very much commoner than at any previous time this season, and, I believe commoner here than I have ever seen them. Premigration flocking is quite apparent."
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> "April 16, 1940. Forty to 50 juncos were present, some in bushes on south side of lake, others feeding on banks of lake exposed now following drainage of the water. They were singing freely and apparently mating."

Very few individuals were seen on the nine recorded occasions in 1937, an indication of diminished numbers in that year.

Some juncos apparently relished the larch buds while others preferred bread fragments which had been distributed on the ground by nature enthusiasts. At different times other species were noticed feeding peaceably with the juncos. On one morning a tree sparrow remained for some time with a group of these birds; at other times they were associated with ruby-crowned kinglets, white-throated sparrows or English sparrows.

Occasionally the dull colored female was recognized alone or in company with several males, and sometimes near mid-May, a detached pair was seen. Depletion in their ranks was noticeable near the end of the vernal visiting period in the park.

Many people know this species by the common name, "snowbird" or "black snowbird," and are familiar with the frequently uttered, smacking note; some recognize the whispered warble song; and still others know the dark colored bird by its "peeping white petticoat" which is exposed in flight.

The junco nests commonly at higher elevations not far from Albany, as the top of Mount Greylock, Berkshire county, Massachusetts. The junior author saw one bird on June 12, 1941, in Thacher State Park, which acted like a nesting bird, suggesting a possible closer breeding area. The majority, however, nest farther north in New England and Canada.

No doubt the frequent visits of this friendly winter visitor are beneficial to this 90-acre park as it consumes many dormant insects and thus helps to hold in check certain enemies of the vegetation. The slate-colored junco is known to feed freely on weed seeds and is therefore helpful to the surrounding farming areas as well.

Eastern Tree Sparrow *Spizella arborea arborea* (Wilson)

Length about 6.25 inches; crown chestnut-rufous; cheeks and nape grayish; two conspicuous white wing bars; underparts dingy-whitish, grayish brown on the sides, with a black spot on the center of breast.

The tree sparrow is another common winter visitor in Albany county; it was not seen often in Washington Park, however, nor would we expect to see it many times as it is a bird of open country. Probably our four records in as many years of only one or two individuals each trip were of stragglers, as the northern migration of eastern tree sparrows to their breeding ground in Canada is usually well along by the early half of April.

On our latest date of May 11, 1935, which is a late sectional record as well, one bird was observed feeding on larch buds with a group of white-throated sparrows. Again only one individual was seen with a flock of juncos on April 18, 1941, and on April 11, 1942; in the first instance, the group was feeding first on the ground and then in the low branches of the larches. On the second date they were feasting on the flowering quince bushes on the north side of the lake. Our earliest park record, which was also our only listing of two tree sparrows together, was on April 10, 1944. They, too, were associated with juncos in picking at buds in the honeysuckle bushes and foraging in the dead leaves beneath; this was near the closed roadway south of the lake in rather a protected spot.

From these few records, we note that this large-sized sparrow is not averse occasionally to taking advantage of the food and protection provided by the cultivated plantings of shrubs or trees in a city park. It is well known, where the species is in rural areas and in greater numbers, that it is distinctly beneficial and consumes many ragweed, smart weed and other injurious weed and grass seeds during its winter sojourn.

The "winter chippy," as the tree sparrow is sometimes called, has a beautiful canarylike song. It is not really in best voice when making its spring appearance in the park. A number of them singing softly in a group during the latter part of winter provides a sweet musical chorus which is well worth pausing to hear. We have often heard them sing, especially during February and early March, from bushes along the country roads. The small, round black spot on the plain, whitish breast serves as a definite identification mark and differentiates the tree sparrow from other members of its family.

Eastern Chipping Sparrow

Spizella passerina passerina (Bechstein)

Length about 5.5 inches. Crown, rufous-chestnut; back, brown streaked; black line through the eye and a white one above it; bill black; rump ashy-gray; underparts grayish white.

This friendly bird, which is an abundant and common summer resident, was seen and heard every year in Washington Park between April 12th (1938) and June 20th (1938). Summer dates as well could be added as the species nests here. It is seventh on our list of commonest birds.

Even though the chipping sparrow winters mainly in southern United States and does not travel such great distances in migration as do some of the warblers, only one or two individuals were noted each morning on the early arrival dates. Before long in different sections, however, several birds were seen or heard delivering their cheerful chipping trill over and over. They were feeding on the ground or singing from the pines or larches or other trees; we have observed them perched both high and low but perhaps more frequently in the lower branches.

Occasionally in early April, one or two chipping sparrows have been seen associated with a group of juncos, but more often they were solitary. As they are such persistent singers we repeatedly became aware of their presence and identified them by note long before any individuals could be located. These amicable little birds, which are not easily frightened, give pleasure to many people. Park visitors who occasionally distribute food become interested in watching them, especially when they accept some of the bread or other eatables that have been scattered on the ground.

We recorded on May 27, 1939, that the numbers of chipping sparrows had been reduced to a few so that perhaps only three to five breeding pairs were in residence, which is about the usual number. One evidence that the "chippy," as it is often commonly called, nests in the park was noted on June 20, 1938, when an adult was observed feeding fledglings on the ground.

As this species is known to raise two broods in a season, it was not surprising that we noticed an individual pulling rootlets for nest material at the base of a large elm on June 14, 1940. The nest, built largely of grasses and rootlets and lined with hair, may be placed either among herbage on the ground or in the lower bushes or trees from two to 20 feet above the ground. We found one seven feet up in a small apple tree and another eight feet up in a white oak tree not far from the city, each containing four eggs. The chipping sparrow is often parasitized by the cowbird; we suspected this to be true in the park, as morning after morning, during egg-laying period, a male cowbird was seen at his lookout post in the top of a tall ginkgo which overlooks the spruces on Englewood place, where the chippies persistently held forth.

This unassuming, small, slim-looking member of the sparrow family is beneficial as the adults feed on weed and grass seeds, and use great numbers of green caterpillars in feeding the young birds.

Eastern Field Sparrow *Spizella pusilla pusilla* (Wilson)

Length about 5.5 inches. Crown and upper parts in general, chestnut-rufous; sides of head grayish; bill pinkish; tail slightly forked; underparts plain whitish.

While the field sparrow is a common summer resident in Albany county, it was observed in only five years of our first decade of study in the park. The usual habitats are pastures, bushy growths and margins of woodlots, rather than city areas. It was recorded twice in 1933, 1936 and 1942; four times in 1938, and once in 1941; only one individual was noted on each of these dates except one. A lone bird was seen on the ground with feeding chipping sparrows and juncos on one occasion. Then on another date two birds were seen with house and white-throated sparrows, all apparently hunting for food in the leaves beneath the ash trees on the slope south of the lake. On another occasion we saw an individual feeding alone in and beneath the near-by larches.

On the mornings of April 15, 1941 and June 13, 1942, our earliest and latest dates, one bird was heard singing the characteristic song volubly and persistently. When an observer is able to locate this plaintive-voiced sparrow, which has a ventriloquial song, he finds that the pinkish bill serves as a good character for final identification. Often the bird sounds far away when it really is singing from a near-by perch and sounds like *"oh! dear, dear, dear, pity me, pity me"*; this phrase starts out slow and loud and then goes faster until it fades away in a hurried, high ending. While the singing individual may be comparatively close or distant, its very fine, high-pitched voice has a marvelous carrying quality.

On June 6, 1941, not far from Albany we found a nest containing four spotted eggs, two feet from the ground in a blackberry bush. Then on June 27th, of the same year, an empty but completed nest was detected in a grassy swale in a near-by pasture. On June 30th, there were three eggs in this new domicile, and four on July 2d, which in weight averaged 1.8 grams.

The consumption of destructive insects and weed seeds makes the field sparrow a beneficial species, and it is a pleasurable one to the many who recognize its distant-sounding, musical song.

Eastern White-crowned Sparrow

Zonotrichia leucophrys leucophrys (Forster)

Length about 7 inches. Conspicuous black and white stripes on head; crown, nape, sides of head and breast grayish; wings and back with a buffy, white and dusky pattern; tail dusky.

This beautiful, conspicuously crowned bird is a rather uncommon migrant in Washington Park; it was recorded in seven of the 14 years of this study. Most of these appearances were between May 8th and 18th; we listed a single individual on April 26, 1939, however, which is also an early regional record; and in 1946, another solitary bird was seen on May 2d. On a few occasions several individuals were observed with a group of white-throats and English sparrows. All appeared to be busily feeding and scratching among the dead leaves on the ground, and when disturbed, the birds would hop up to lower branches of bushes or trees or even higher in larches or other trees where they would again pause to feed for a short time.

On only one morning did we hear the white-crowned sing; this sparrow seemed content to leave most of the vocalizing to the closely related species, the white-throat. While their songs are similar, this bird appeared to repeat the latter part of the white-throat's song as large sparrows and stand with heads held high. Their posture suggests pride in the rich velvety, striking, black and white, puffy crown. This uncommon visitor nests north of Albany in the Hudsonian and Canadian Zones; it winters in southern United States and Mexico.

White-throated Sparrow *Zonotrichia albicollis* (Gmelin)

Length 6.75 inches. Chin and throat white; yellow patch before the eye; four black stripes and three white ones on the top and sides of head; upper parts in general streaked rufous-brown; with less gray coloration than the white-crown.

To many, one of the most welcomed accompaniments of spring is the appearance of the white-throated sparrow; this common transient appeared in various numbers in every year of this study. It was rated as 13th bird on 1933-42 frequency of appearance table. First arrivals were seen on April 14th and 18th in 1945 and 1946 and others on April 19th in 1934, 1938 and 1941. May 31, 1937 was the latest spring record.

If the spring season is late, that is, when the weather has been continuously cold, then the white-throats also are late in their arrivals; for example, our first record for 1935 was May 8th, and for 1940, May 1st. Usually a single individual appears first and often it may be heard before it is seen; this is due partly to its coloration which blends well with the surroundings and serves as an effective camouflage. From this first appearance their numbers increase until about in a week, as a rule, they are fairly common.

In some years a pronounced migratory movement is manifest. This was evident on May 6, 1939 and May 5, 1941; it was especially marked in this latter year. From April 19, 1941, when one bird appeared until the end of the month, the numbers were gradually augmented. Then on May 1st, we recorded "an evident local incursion since yesterday." The climax is thus described in field notes for May 5, 1941:

> "Very abundant this a.m. More abundant than any time we have ever observed in one area. Evidently a very large definite concerted incursion into the park along with the current shower and warm weather. Never have we observed so definite a movement of such a large number of these birds. They are on the ground, in bushes, in trees, even well toward the tops of the tallest ones.
>
> "On a bare area approximately 100 by 100 feet at the base of a large elm we counted 50 or more individuals and would estimate that at least 1000 birds of this species were in the park at one time this a.m. Singing is loud, constant and, at times so prevalent, as to bewilder the observer."

Again on May 6th at 6 a.m., as the heavy fog began to lift, a chorus of white-throats was heard and numerous individuals seen; not quite so many, however, as were noted on the preceding morning; yet they were still abundant enough to make an almost bewildering choir of voices.

Three days later, the count of individuals had fallen off markedly and the singing was less persistent, and by the 12th, very few birds remained in the park. An occasional one could be heard on the 16th. In all, the species was listed on 25 trips taken between April 19th and May 20th, with the greatest number present on May 5th.

Their abundance and length of stay in this city area is regulated somewhat by the amount of trimming given to the shrubbery. In many years little of this was done. In certain years, however, for example in 1942, the bushes and trees were kept well trimmed, and this reduced protected hiding places for birds. Perhaps this is one of the reasons for our report on May 1, 1942, that this species was much scarcer than usual in the park that season. While the numbers were increased somewhat by May 4th, there still were not many birds present nor any evidence of a marked movement.

Occasionally one or more white-crowned sparrows may be seen associated with the white-throats. Both species are large for their tribe and both have black and white stripes on the head. But as indicated by their names, one bird has a prominent white crown and the other, a definite white throat; the latter species has, in addition, a small yellow line before the eye and on the bend of the wing which serve as identification characters for all ages and sexes.

One fall date of October 16, 1943, is given as it indicates the time of appearance of the autumnal southern movement through Washington Park; at 10.15 on that morning, white-throats were not only seen, but heard singing as well. Occasionally one or two are reported wintering here.

The song of the white-throated sparrow is quite distinguishable and provides a thrill to both amateur and professional ornithologists. It consists of a high, clear, plaintive whistle, which in New England is likened to the words *"Old Sam Peabody Peabody Peabody,"* while farther north, where the bird nests, it is interpreted as *"Oh, sweet Canada, Canada, Canada."* The first two notes, however, with the second usually higher-pitched (though sometimes lower-pitched) is delivered in a staccato manner and the remainder runs into a triple trill that fades away as it ends in a lower pitch and generally in a minor key. The beautiful phrase which is so markedly distinct in the morning chorus of bird music is repeated at intervals as the individual stops momentarily from its search of insect food on the ground, or rests on a low limb of a tree.

This species nests in Canada and on high points in New York and other northern states and winters mainly in southern United States. The brief visit of this harmonious songster in our city area gives pleasure to many people and especially happy are those who learn to recognize its impressive song which we deem the sweetest melody given by any sparrow.

Eastern Fox Sparrow *Passerella iliaca iliaca* (Merrem)

Length 7.25 inches. General coloration above reddish brown, brighter on the tail; breast and sides heavily streaked with reddish brown; bill short with lower mandible yellowish.

Not many people see and hear the fox sparrow although it is a fairly common migrant in Albany county; we noted it on only ten April trips in four different years as a park visitor. Perhaps we would have found the bird oftener had more study trips been taken in March.

The earliest and latest records are included in the following six dates in 1939. On April 1, a single individual, very shy and wary, was seen hiding in the bushes on the north shore of the lake; this was our third record, having previously listed it on April 8 and 13, 1937. Eight days later one bird was singing in private grounds near this same place and it then flew into the park; again in a week another bird was singing freely here. A solitary individual was listed on April 19th, 21st and 24th from the other side of the lake. Perhaps the same individual was heard and seen on all of these six trips. The song is beautifully clear and musical. Bicknell in Chapman (1932, p. 539) says: "Its song is not surpassed by that of any of our sparrows." Harmonious as we find this song, however, we still enjoy most the refrain of the white-throat.

On April 8, 1940, the first and only record for this season was of one bird associated with a small flock of juncos, first on the ground and then in the low bushes on the northern slope near the west end of the lake. Three fox sparrows were seen on April 6, 1942, in the same locality. These dates indicate that this and the song sparrow are two of the earliest migrants to appear in the park. Of all the birds bearing the sparrow name which we record in the Albany area, this is the largest, a character which provides helpful field identification.

This attractive sparrow, which is mainly terrestrial in its habitats, makes quite a disturbance as it scratches vigorously among the dead leaves on the ground for food. It is essentially a bird of the thicket and woodland and can not be expected to remain long in a city area. The breeding range includes northern Canada and Alaska.

Eastern Swamp Sparrow

Melospiza georgiana georgiana (Latham)

Length about 5.5 inches. Crown reddish, forehead black; eye with grayish line above and blackish line behind; sides of head and breast grayish; throat and abdomen white; upper parts streaked; wing coverts chestnut; tail rufous-brown.

This fairly common Albany county summer resident was recorded in 1933 and 1944 in Washington Park. In the latter year on May 4th, a single individual was seen on the ground among low bushes just north of the lake house. No song, but only the sharp *"cheep,"* was heard of both this individual and the one identified on May 6, 1933.

As its name indicates, the favorite habitat of this sparrow is in low swampy thickets or marshes so it would not be expected frequently to visit a well-kept city park.

The swamp sparrow which is quite shy, may be distinguished from its near relative, the song sparrow, by its unstreaked breast.

Eastern Song Sparrow *Melospiza melodia melodia* (Wilson)

Length about 6.25 inches. Upper parts brownish streaked; line over eye grayish; underparts white and streaked with blackish on the breast and sides, the marks on the center of breast becoming confluent to form a large blotch.

Probably the two species of the sparrow family (not including the introduced English sparrow which is a member of the weaver bird family) best known to the public are the song and chipping sparrows. The cheerful song of the former, which is a very common county summer resident, greeted us every year of our study. In the early spring it not only is commonly heard and seen in Washington Park but in near-by back yards as well. Each season this songster maintains its habitat in country gardens, roadside shrubbery and bushes near buildings or the edges of woods; we have found their nests in all of these mentioned places. While it is probably the most abundant sparrow nesting in the county, its nests were not found by us in the park. In 1946, however, when it was recorded by the junior author on every trip except one, its song came from a suitable nesting area on both June 6th and 16th, giving us circumstantial evidence of its nesting within the park. In the first warm spring week in 1945, the song sparrow was heard singing faintly on the early date of March 18th, yet most of our records for its first appearance here are from March 24 (1938) to May 8 (1939 and 1940).

As this sparrow ranks tenth on 1933-42 frequency list of birds seen in Washington Park, some of the substantiating records will be given.

Several individuals were observed on April 8, 1937, whereas the week before only one bird had been seen in the course of an hour. This is quite typical of their number and manner of spring arrival in this sanctuary.

The song sparrow appeared and disappeared earlier in 1938. Several individuals were recorded on March 24th and by the last week in April very few were seen. The season had been characterized by an unusually prolonged period of warm, sometimes hot, weather. Possibly this influenced them to disperse earlier than usual to their nesting localities. While 12 to 15 individuals, our greatest number reported for any one date, were listed on April 21st in 1939, only one or two were recorded each trip by May 8th.

This species seemed to be much less prevalent in 1940 than in the previous years. Again in 1941 it was heard not in numbers at one spot, but in many localities in the park, even in the southeast corner near the Madison Avenue and Willett Street intersection, which has streetcar and other traffic noises and where few birds except the English sparrow, starling, robin or an occasional grackle are observed. We have heard this song through the open window in our eighth floor apartment at 11.30 o'clock in the morning on one occasion, but more often at earlier hours on other days, the voice coming across the street from the park or from adjoining yards on State street near

Northern boulevard. At least a half dozen individuals were singing volubly during the morning trip on April 16, 1941, when we recorded it to be commoner than it had been since 1939.

The song sparrow was seen frequently while feeding upon the ground or while resting or singing in low bushes, and was also noted at the water's edge and at various heights in near-by trees. It is thus adaptable to different levels.

Often before the song is delivered, the individual flies up to a low perch and pours forth his music, perhaps repeating it several times before he drops down to the ground to feed again. This refrain has many variations but usually begins with two or three loud clear notes and descends to a trill. The modifications, as well as the different pitches, as given by various individuals, along with the frequency with which they are offered, are sources of pleasure to the auditor. Hearing one of these variants the nonprofessional may feel sure that he has heard a rare and unusual bird, while the experienced ornithologist recognizes a familiar avian friend. The first few trials at song in the early morning by an individual may be abbreviated and somewhat squeaky. When the complete refrain is delivered, however, it resounds clearly and may be heard a block distant as shown above. Sometimes it seems to be the principal voice in the park bird chorus. Even the metallic *"chip,"* which is given when the bird is disturbed, is distinctive and helpful in identification.

Two or more broods may be hatched in a season, which partially accounts for their number in the Albany region. This little brown-streaked bird with a prominent spot on its breast is well distributed throughout this country. It is interesting to note that our common eastern song sparrow is one of some 25 subspecies occurring in the United States; they are all similar in appearance but, living in different sections of the country, have minor distinctions and have been given different geographical names. The two that are nearest to us are the Atlantic song sparrow and the Mississippi song sparrow which may be found, respectively, to the south and west.

A few individuals spend the cold months in this part of the State but most of them winter from southern New York to Florida. According to McAtee (1926, p. 62) "about one-third of the song sparrow's food is made up of insects and other small animal forms and two-thirds of seeds and other parts of plants. Weed seeds are the most important element of the vegetable food . . . the song sparrow does not fail to encounter and devour various insects that are destructive to trees."

The scientific name of *Melospiza melodia,* which means sweet-singing song, well describes the bird's musical expression. This friendly sparrow, which so frequently attracts attention to itself by its cheerful singing, is a welcome visitor or resident in city or agricultural areas for both its esthetic and economic values.

EARLIEST AND LATEST RECORD AND NESTING STATUS

For the convenience of the observers of the birds of Washington Park who wish to check the time of their arrival and departure, either over or in the park, we list alphabetically the 122 species and subspecies which were recorded during this 1933-46 study (see table 5). This gives our earliest and latest spring dates, including the years when these were noted. A few fall records, nesting status and total number of years recorded during the 14 years of this study are also given ; one date alone is designated for a species which was seen only once. For brevity the months and years are shortened as for instance the fourth month and twenty-second day in 1942, is given 4/22/42 instead of April 22, 1942.

The birds which are reported on 10, 11, 12, 13 and 14 years are considered the commonest of the total of 127[1] species listed for Washington Park in this bulletin. It is interesting to note that not all of these are included in the table 2, p. 30, which gave the 50 commonest ones for the first ten years of this work. This illustrates the variability of occurrence over a longer period of study and also, that a species may be observed on many trips during one year and then not seen so frequently for a number of years. For example, the red-breasted nuthatch was reported on 17 and 15 trips for 1938 and 1941 respectively, yet it was recorded on only eight of the 14 years covered by this study.

Under *nesting status* x denotes birds nesting in the park and y denotes birds nesting in areas adjoining the park.

[1] The five additional birds added to our list of 122 are lesser scaup duck, reliably reported for March 29, 1945, and mockingbird, yellow-breasted chat, orchard oriole and vesper sparrow recorded by Judd (1907).

TABLE 5

Name	Earliest Record	Latest Record	Nesting Status	Total Years Recorded
Blackbird, rusty	4/22/42	5/ 6/40	....	3
Bluebird, eastern	3/29/35	5/ 8/40	....	5
Bobolink	5/ 9/38	5/20/41	....	7
Buffle-head	4/22/41	4/23/41	....	1
Bunting, indigo	5/11/35	5/26/46	....	7
Catbird	5/ 1/41	7/26/42	x	14
Chickadee, black-capped	1/ 8/38	5/19/42 10/13/43	....	12
Cowbird, eastern	4/13/36	6/ 6/46	x	13
Creeper, northeastern brown	3/18/46	5/ 4/42	....	11
Crossbill, red	3/30/41	5/ 9/41	....	1
Crow, eastern	1/ 8/38	6/ 3/42 11/ 1/39	....	14
Cuckoo, black-billed	5/15/40	6/ 3/38	....	3
Cuckoo, eastern yellow-billed	5/11/39	5/31/39	....	1
Dove, eastern mourning	4/ 8/45	5/26/46	y	11
Dove, rock (or pigeon)	1/ 1/33	12/31/46	x	14
Duck, black	5/18/37	6/ 3/38	....	3
Finch, eastern purple	4/ 8/41	6/17/39	....	14
Flicker, northern	3/22/38	9/22/43	x	14
Flycatcher, Acadian	5/ 3/38	5/20/40	....	3
Flycatcher, least	5/ 1/42	6/ 5/40	....	12
Flycatcher, northern crested	5/ 7/38	5/30/42	....	3
Flycatcher, yellow-bellied	5/18/36	6/ 7/41 9/15/43	....	5
Goldfinch, eastern	3/29/45	7/26/42 9/22/43	....	14
Goose, eastern Canada	4/17/43	5/ 8/35	....	3
Grackle, bronzed	3/ 6/46	10/19/41	x	14
Grosbeak, eastern evening	4/14/41	....	....	1
Grosbeak, rose-breasted	5/ 7/41	5/20/41	....	11
Gull, American herring	4/16/44	7/ 1/42	....	5
Gull, ring-billed	3/25/43	5/13/38	....	3
Hawk, common sharp-shinned	4/18/46	....	....	1
Hawk, Cooper's	4/27/40	....	....	1
Hawk, eastern pigeon	5/30/43	....	....	1
Hawk, eastern sparrow	1/ 3/41	12/17/35	y	13
Hawk, northern broad-winged	4/21/41	....	....	1
Heron, eastern green	4/23/46	5/15/37 8/29/43	....	5
Heron, northeastern great blue	4/14/42	4/20/34	....	2
Heron, northern black-crowned night	5/ 2/38	7/21/40	....	13
Hummingbird, ruby-throated	5/11/38	5/31/39	....	9
Jay, northern blue	4/14/42	6/ 7/40 10/13/43	....	13
Junco, common slate-colored	3/18/45	5/18/38 10/13/43	....	14

Name	Earliest Record	Latest Record	Nesting Status	Total Years Recorded
Killdeer, northern	3/24/46	6/ 6/37	....	4
Kingbird, eastern	5/ 4/42	....	....	1
Kingfisher, eastern belted	4/21/39	5/29/39 7/26/46	....	12
Kinglet, eastern golden-crowned	3/24/38	4/29/40	....	11
Kinglet, eastern ruby-crowned	4/ 1/46	5/19/35 9/29/43	....	14
Nighthawk, eastern	5/ 3/43	9/21/37	y	14
Nuthatch, eastern white-breasted	2/29/44	10/13/43	x	13
Nuthatch, red-breasted	3/24/38	5/20/40	....	8
Oriole, Baltimore	5/ 4/38	6/20/39	x	14
Oven-bird, common	5/ 4/42	6/ 1/40	....	14
Owl, eastern screech	1/19/39	12/19/40	y	9
Owl, North American barn	7/10/36	8/13/36	y	1
Pewee, eastern wood	5/ 9/36	9/15/43	x	11
Pheasant, ring-necked	4/ 2/41	5/14/41	....	1
Phoebe, eastern	4/ 4/42	5/18/36 9/22/43	....	8
Rail, northern Virginia	5/10/40	....	....	1
Redstart, American	5/11/36	6/ 7/41	....	10
Red-wing, eastern	3/24/38	5/30/41	....	12
Robin, eastern	3/ 7/37	11/10/37	x	14
Sandpiper, eastern solitary	5/19/40	....	....	1
Sandpiper, semipalmated	5/18/40	....	....	1
Sandpiper, spotted	4/26/38	6/14/40	x	10
Sapsucker, eastern yellow-bellied	4/ 4/33	5/19/41 9/29/43	....	14
Siskin, northern pine	4/18/41	5/29/39	....	2
Sparrow, eastern chipping	4/12/38	7/26/42	x	14
Sparrow, eastern field	4/15/41	6/13/42	....	5
Sparrow, eastern fox	4/ 1/39	4/24/39	....	4
Sparrow, eastern song	3/18/45	6/18/46	x	14
Sparrow, eastern swamp	5/ 4/44	5/ 6/33	....	2
Sparrow, eastern tree	4/10/44	5/11/35	....	4
Sparrow, eastern white-crowned	4/24/39	5/18/39	....	7
Sparrow, English or house	1/ 1/33	12/31/46	x	14
Sparrow, white-throated	4/14/45	5/31/37 10/16/43	....	14
Starling, common	1/ 1/33	12/31/46	x	14
Swallow, American barn	4/17/36	5/25/43 8/12/43	....	9
Swallow, common bank	5/18/39	5/18/42	....	2
Swallow, eastern cliff	5/ 7/46	5/15/37	....	2
Swallow, northern rough-winged	5/ 7 40	....	....	1
Swallow, tree	4/ 4/42	5/18/38	....	6
Swift, chimney	4/26/38	8/10/46	y	14
Tanager, scarlet	5/ 4/42	5/30/40	....	11
Thrasher, eastern brown	5/ 3/41	5/18/38	....	3
Thrush, eastern hermit	4/ 8/40	5/18/40	....	12
Thrush, northern gray-cheeked	5/ 3/36	5/30/41	....	8
Thrush, olive-backed	4/27/38	6/ 3/40 9/15/43	....	11
Thrush, wood	5/ 4/42	7/26/46	y	12
Towhee, red-eyed	4/27/38	5/18/37	....	9

Name	Earliest Record	Latest Record	Nesting Status	Total Years Recorded
Veery	4/28/39	6/ 1/40	....	10
Vireo, blue-headed	4/19/38	5/20/46 9/29/43	....	11
Vireo, eastern warbling	4/28/38	6/20/38 9/29/43	x	14
Vireo, northern white-eyed	5/ 6/33	5/17/38	....	3
Vireo, Philadelphia	5/ 9/39	....	....	1
Vireo, red-eyed	4/30/38	6/17/39 9/29/43	....	14
Vireo, yellow-throated	5/ 1/40	6/20/38 10/ 6/43	x	13
Warbler, bay-breasted	5/10/37	5/19/46	....	2
Warbler, black and white	4/27/34	5/18/38	....	12
Warbler, Blackburnian	5/ 2/44	6/ 7/41	....	14
Warbler, black-poll	5/15/34	6/ 3/38 9/29/43	....	12
Warbler, Canada	5/ 9/38	6/ 1/40	....	6
Warbler, Cape May	5/ 2/42	5/19/40	....	9
Warbler, chestnut-sided	4/28/38	5/20/41 9/15/43	....	13
Warbler, eastern myrtle	4/15/41	5/20/41	....	14
Warbler, eastern yellow	5/ 3/36	5/20/40 9/15/43	....	11
Warbler, magnolia	5/ 3/38	5/31/39 9/29/43	....	14
Warbler, mourning	5/17/41	6/ 7/41	....	3
Warbler, Nashville	4/30/38	5/20/40 9/22/43	....	13
Warbler, northern black-throated blue	5/ 1/40	5/20/41	....	12
Warbler, northern black-throated green	4/30/42	5/30/38	....	13
Warbler, northern parula	5/ 4/44	5/19/39	....	8
Warbler, northern pine	4/24/36	6/ 7/39	....	6
Warbler, Tennessee	5/ 4/38	5/20/46	....	8
Warbler, western palm	4/29/42	5/15/34	....	2
Warbler, Wilson's	5/15/37	5/19/41	....	3
Warbler, yellow palm	4/19/34	5/15/37	....	8
Water-thrush, Louisiana	5/ 6/45	5/31/41	....	7
Waxwing, cedar	3/31/33	5/16/41	....	4
Whip-poor-will, eastern	5/15/45	....	....	1
Woodpecker, eastern hairy	2/29/44	6/13/42	x	5
Woodpecker, northern downy	1/ 8/38	12/13/43	x	14
Woodpecker, northern pileated	4/24/39	....	....	1
Wren, eastern house	4/26/38	6/ 7/39	y	13
Yellow-throat, northern	5/ 4/44	6/13/42	....	13

SUMMARY

1 It is interesting to note that of the 13 orders treated in this report, 18 families, which includes 86 species and subspecies of the total of 122 reported by the joint authors, are members of the order *Passeriformes,* or the perching birds; 41 of these (approximately one-

third of the entire number) belong to two families, 24 to the *Parulidae* or wood warblers and 17 to the *Fringillidae* or grosbeaks, finches, sparrows and buntings.

2 The total number recorded for Washington Park is 127 when the five additional species noted by other observers are included.

3 The greatest number we listed in any one year was 87 in 1940.

4 The longest list on any one day was 52 on May 18, 1938.

5 The following four birds are considered permanent residents of Washington Park: downy woodpecker, pigeon, starling and English sparrow. In addition the sparrow hawk and white-breasted nuthatch are seen practically every month of the year.

6 Species nesting either in or very close to the boundaries of the park number 26.

7 The records summarized in this report are for ten years of intensive study 1933 to 1942, and for four years of part-time observations, 1943 to 1946. The value of an extended observation period is emphasized as species were added to the list from year to year.

8 This study emphasizes the possibilities of a conveniently located city park for city dwellers who wish to learn to know the birds in their region. Observers who will make the effort in spring and fall months and who are persistent may identify many of the migrant and resident species not only in Washington Park, Albany, New York, but those in similar parks in other cities, where, probably the bird life is as plentiful.

ADDENDUM

Since this report was finished, one record that is worthy of note has been reported, and several changes have occurred in Washington Park.

1 The red crossbills, which were here in 1941, made a reappearance in Washington Park in 1951. Observers recorded seeing them in numbers from a few to nearly 50 individuals between the inclusive dates of April 22 and May 31, 1951. Again they were usually seen in or near the three larch stands. In mid-May they appeared quite fearless of the many visitors who watched them when they were busily feeding either on the ground below the larches or up in the trees. By May 25th, however, the birds would fly into a tree in the park then suddenly fly off again as they appeared nervous and unsettled. Since they were not noticed every day of the six weeks' period, yet during this time they were seen in small numbers in several places that were ten or more miles from the city, we suspect that they may have been birds of the same flock.

2 For the past few years, Albany has celebrated a tulip festival in Washington Park in mid-May or soon thereafter. Huge crowds visit the park to enjoy the beautiful display of some 10,000 blooms. This is also the time of the month when bird migration is at its height. Since birds are easily frightened, perhaps the many human visitors may partially account for shorter lists of species and individuals in later years.

3 Many elms and other trees in the park have been cut down recently because they were diseased or damaged by storms. There has also been a greater trimming of bushes and undergrowth. This means less protection for wild birds and may further diminish their numbers in this city area. While bird students may not now get lists of 81 or 84 species and subspecies, they may, if persistent, still learn to know many of the 127 birds which are recorded in this report.

RECOMMENDED MANUALS

In recent years various books helpful to the bird student have been published. Among them may be mentioned:

1947 **Peterson, R. T.**
A field guide to the birds giving field marks of all species found east of the Rockies; 2d rev. ed. Houghton. Boston, Mass. xxiv+290p. $3.50
Contains 1000 illustrations by the author, 511 in full color

1946 **Pough, R. H.**
Audubon bird guide: Eastern land birds. Doubleday. N. Y. xxxvii+312p. $3
Has 48 colored plates by Don Eckelberry illustrating every species of eastern land bird

1946 **Hausman, L. A.**
Field book of eastern birds. Putnam. N. Y. xvi+659p. $3.75
Black and white illustrations of every species (of both land and water birds) and six colored plates of more difficult groups, by Jacob B. Abbott

1943 **Hickey, J. J.**
A guide to bird watching. Oxford Univ. Press. N. Y. xiv+262 p. $3.50
Illustrations by F. L. Jaques and a series of shorebird tracks by C. A. Urner

1932 **Chapman, F. M.**
Handbook of birds of eastern North America; 2d rev. ed. Appleton-Century. N. Y. xxxvi+581p. $5

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Geology and Mineral Resources

of the

Oriskany Quadrangle

(Rome Quadrangle)

BY

NELSON C. DALE PH.D.

Temporary Geologist, New York State Museum

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CONTENTS

ILLUSTRATIONS

GEOLOGY AND MINERAL RESOURCES OF THE ORISKANY QUADRANGLE*

By Nelson C. Dale, Ph.D.

Temporary Geologist, New York State Museum

PREFACE

From the standpoint of rock formations, abundance and variety of fossil faunas, interesting surface features and economically valuable deposits, the Oriskany quadrangle has offered in years past and still offers much to the science of geology. These interests have been considered in the works of many distinguished geologists among whom may be mentioned Vanuxem, Emmons, Newland, Hartnagel, Smyth and Ulrich. The main objective of this bulletin is the presentation of a geological map together with brief descriptions of the physiography, stratigraphy, paleontology, lithology and the historical economic geology of the region. Included also is the assemblage of known facts now scattered throughout the literature, together with new facts acquired by the writer from close contact with the region for many years.

Indebtedness is here acknowledged for many favors rendered by members of the staff of the New York State Museum, to Professor H. L. Alling for his many valuable suggestions, to Dr Tracy Gillette for his paleontological contributions and for the valuable field assistance and photography of P. A. Schafer, D. W. Meredith and W. H. Parsons, instructors in the Department of Geology at Hamilton College. Appreciative acknowledgment is also made to Harold Van Caldwell, Hamilton '40, for his fine fossil drawings both from the originals and from published illustrations.

* Manuscript submitted April 1942.

The name Oriskany Quadrangle was changed to Rome Quadrangle, upon republication following new topographic surveys in 1941-1947.

INTRODUCTION

GEOGRAPHY AND LOCATION

The area of the Oriskany quadrangle includes approximately 220 square miles, extending 17¼ miles from north to south and 12¾ miles from east to west, and is bounded by the parallels of 43° and 40° 15′ and the meridians of 75° 15′ and 75° 30′. The area is about 100 miles west of Albany and 45 miles east of Syracuse, entirely within Oneida county, in the east-central part of New York State. In its geographic and geologic relations it forms a part of the north central margin of the Appalachian plateau, or Allegheny cuesta, and also a part of the interior lowlands known more specifically as the Mohawk Valley trench, or the Erie belt line, and the outface slope of the next succeeding cuesta to the north.

TOPOGRAPHY

The area is largely concerned with the northern front of the Allegheny plateau, or what is more specifically known as the Allegheny cuesta, though only a part of the inface slope of this cuesta occurs. As a major topographic feature this cuesta rises from the Mohawk valley, which is considered to be an extension of the interior lowlands to the west. The surface of the cuesta is deeply dissected by two important north-flowing tributaries of the Mohawk, the Oriskany and Sauquoit creeks, while the interstream areas are dissected to a lesser extent by their tributaries. One of the larger of the tributaries of the Oriskany, known as Deans creek, is responsible for the erosion features in the southwestern part of the area.

The northern slopes of the Allegheny cuesta measured from the tops of Prospect and Paris hills to the Mohawk show drops of 66 and 44½ feet to a mile, respectively, in 11½ and 9½ miles. Were it not for certain steplike elevations, where the Clinton, Salina, Manlius and Coeymans outcrop, the inface slope of the cuesta would dip quite uniformly to the Mohawk.

The Mohawk-Susquehanna divide, marking the summit of the Allegheny cuesta and occurring off the area to the south, in the vicinity of Bouckville, has been steadily migrating southward since the initiation of the Mohawk Valley trench. Although most of the trenching was accomplished in preglacial times, it is generally believed that the great volumes of melt-waters coming from the continental ice sheet and the great proglacial lakes were responsible for some changes. The undermining of the harder members of the Silurian, such as the Oneida, Clinton etc., has been going on steadily, causing the migration of this divide.

The east and west slopes of the Sauquoit and Oriskany valleys show differences in angle of slope, which differences might possibly be assigned to the abrasive and gouging action of the continental ice sheet. From the Oriskany creek at an elevation of 580 feet

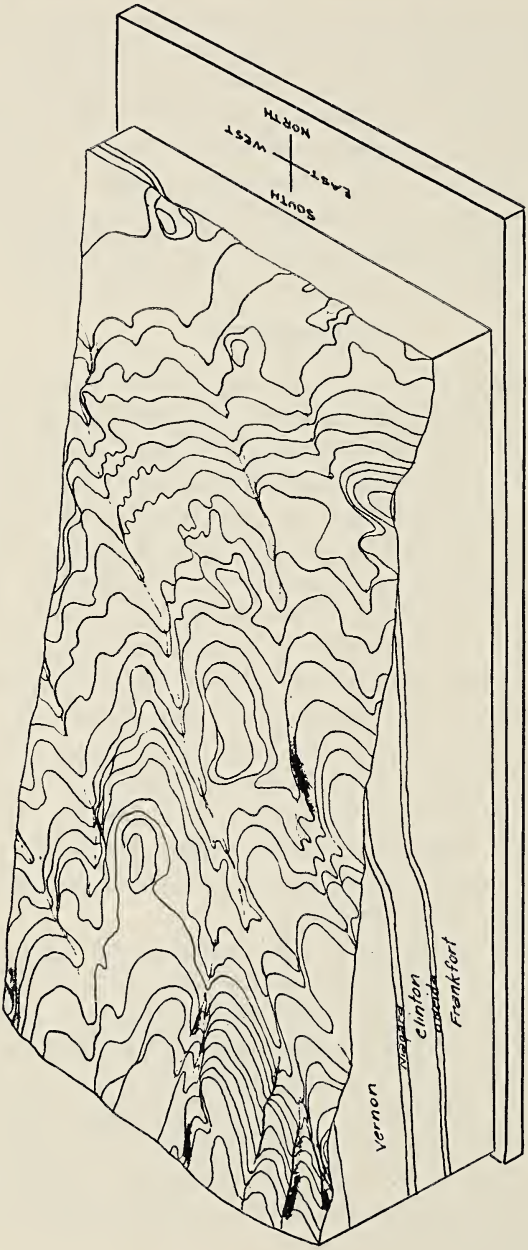


Figure 1 Isometric projection of portion of the Oriskany area, showing topography and section through monocline. (Drawn by P. A. Schafer)

southwest of Clinton to the top of Prospect hill, at an elevation of 1380 feet, there is an increase of 800 feet in two and one-half miles, or a rise of 320 feet to a mile; while from the Oriskany to the top of Paris hill there is a rise of about 171 feet to a mile. A similar comparison might be made between the east slope of Paris hill and the west slope of Prospect hill. As one can see from this comparison, long uniform west slopes and steeper east slopes are the rule. Figure 1, an isometric projection of this region, shows this contrast, according to Schafer's concept (1926, p. 2). Too few observations have been made in this region from which any conclusive generalization could be drawn as to the cause of this difference between the east and west slopes.

The northern part of the quadrangle is occupied by the Mohawk Valley lowland and what would appear to be an outface slope of another cuesta to the north, both of which have been carved out of the Utica and Frankfort shales in preglacial and postglacial times. The axis of the valley is marked by the contact between the above formations and is essentially the course of the Mohawk river. The Mohawk, a meandering stream for the most part, although canalized here and there by the Barge canal, flows on a flood plain of a mile or so in width. This plain on the Oriskany sheet from Rome to Utica is for the most part a featureless one given over largely to agriculture, transportation routes and, more rarely, to brickmaking. Conspicuous terraces formed by glacial Lake Amsterdam on the southern side in the vicinity of Whitesboro and in the north near the site of the Utica airport, as well as at the mouth of the Oriskany, appear as important physiographic features of this region. Abandoned river courses like that of Nine Mile creek between Holland Patent and its mouth at the Mohawk, along with the first glacial successor, West Canada creek, have succeeded in leaving records of the ice and its melt-waters. Where the Mohawk changes its south-flowing direction just east of Rome, the point of divide between the St Lawrence and the Hudson, the valley widens out considerably to the west into a region obviously affected by the ice and its glacial waters. The development of the Mohawk river and its tributaries will be further discussed later.

The difference between the lowest and highest points of elevation above sea level in this area, or its maximum relief, is 1127 feet, the low point of 415 feet being found near Utica and the high point of 1542 feet at Paris hill. The relief in the separate parts of the Mohawk valley varies considerably. That of the lowlands descends from an elevation of 506 feet north of Rome to 415 feet at Utica, showing a relief of less than 100 feet, while in the uplands of the cuesta a relief of 600 and 700 feet is quite common. The upland and valley aspects are shown in figures 2 and 3 and map 1.

So far as can be determined, the valleys in no way appear to have been controlled by any structural causes other than those furnished by a series of gently-dipping strata which our newly adjusting drainage system inherited. As shown in the discussion of the history of the drainage system on page 145, the Mohawk valley is largely the product of subsequent stream erosion while the Oriskany and Sauquoit valleys were produced by obsequent stream erosion. It is believed (Fairchild, 1925), however, that a consequent Susquehanna system may have traversed the region from north to south, but as a result of piracy by the ever-growing Ontario system of which the Mohawk and its north-flowing tributaries were a part, the southerly migration of the Hudson-Mohawk-Susquehanna divide and reversal of the drainage in the Oriskany and Sauquoit obsequent tributaries all happened during the development of these valleys.

The scenic effects of the Mohawk and its tributaries, the Oriskany, Sauquoit, East and West Canada creek, have long been noted. Among other streams of noteworthy beauty, though to a lesser degree, might be cited some of the smaller tributaries north of the Mohawk, such as those west of Holland Patent and Floyd, which flow through steep ravines in the dark shales of the Utica and Frankfort, as well as those south of the Mohawk and tributary to the Oriskany creek, such as the Kirkland Ravine creek south of the Hamilton College campus which flows in the picturesque red Vernon shale. The Willowvale creek, a tributary to the Sauquoit which is cut in the Clinton formation, has attractive waterfalls made by the more resistant iron ore members which traverse this stream, as well as by dams.

So far as can be determined, the prevailing type of topography seen in the uplands and valleys is largely the result of differential erosion, the valleys for the most part having been cut in the softer shale rocks, while the interstream areas consist of shales with harder intercalated limestone members, the latter capping the hilltops.

Such topographic features as were produced by the continental ice sheet and its resultant melting waters comprise the minor features of this area as seen in the conspicuous Lake Amsterdam features on either side of the Mohawk and south along the Oriskany at the 620-foot contour. A conspicuous esker (figure 3) in the vicinity of Oriskany, as well as the few isolated kames seen near Clinton and Oriskany, all bear testimony to the work of the melting ice sheet in this region. Several small kettle holes in the vicinity of New Hartford and outwash areas in the Clinton region show well on the map, but due to recent construction work and road building

Figure 2 View looking east from West hill across Oriskany valley. (Photograph by N. C. Dale)

Figure 3 View looking west from East hill across Oriskany valley. (Photograph by N. C. Dale)

they are fast disappearing as topographic features. Glacially laid deposits of till found distributed over the area to a depth of 20 to 30 feet have modified and subdued the topography considerably. A detailed description of these glacial deposits may be found in the chapter in which Pleistocene deposits are considered.

PENEPLANATION

As the part of the Allegheny plateau represented here consists merely of an inner lowland and an inface slope of the Allegheny cuesta, it is difficult to decipher the history of peneplanation. South of the divide between the Mohawk-Hudson and the Susquehanna drainage systems, that is, a line passing through Cassville, Waterville and Oriskany Falls, which are all south of the Oriskany sheet, the hilltops are composed largely of Devonian rock and are of nearly the same elevation, facts which point not only to their plateau origin, but also to a greater northward extension of the Devonian sediments. No outliers of the Devonian have been found north of the Mohawk, but it is certain that the Devonian sea must have extended as far as the Mohawk, and probably beyond. Whatever overlying beds of later Devonian age once extended over this region have long since been stripped off through erosion. As the result of erosion of the inface slope of the cuesta and the southward migration of the divide, as well as the cutting of the Mohawk trench, there is a lack of accordance in elevations throughout the higher parts of the area. The bed of the Mohawk, however, extending from an elevation of 460 feet at Rome to sea level at Cohoes, suggests a continuous eastward sloping plane, possibly to be identified as the Albany (Somerville) peneplain, with a break at Little Falls, where the preglacial divide, a product of late Tertiary times, was located. Whether the summits of the hills of this area, with elevations between 1382 and 1500 feet, may correspond in a most general way with the Schooley peneplain is questionable. Not until there have been many projected profiles from quite a number of maps in this region will we have any definite opinion as to the

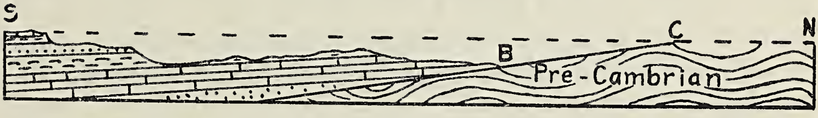


Figure 4 General topographic relations of the Allegheny plateau. Mohawk lowland and nonmountainous edge of the Adirondack Upland. Exposed Paleozoic rocks: Ordovician, Silurian and Devonian. SN represents the Schooley peneplain somewhat reduced. The valley floor is imperfect Late Tertiary (Harrisburg ?) peneplain. BC is a pre-Paleozoic peneplain exposed by stripping since the Schooley peneplain was uplifted. Vertical scale about eight times the horizontal. (From H. P. Cushing, State Mus. 95)

correlation of its peneplains with the major peneplain surfaces. It would appear to the writer that the Mohawk valley represents an undeveloped or interrupted Harrisburg peneplain, and the higher parts beyond and including the southern parts represent the Schooley. For further discussion of the peneplains the reader is referred to the Cenezoic history (figure 4).

DRAINAGE

The Oriskany area shows parts of two drainage systems, that of the Ontarian found west of Rome and the Hudson-Mohawk which drains the greater part of the region. None of the area at present is drained by the Susquehanna. Originally, in preglacial times, before the Mohawk trench was cut, the St Lawrence-Ontarian system drained most of the area west of Little Falls, that system now being represented by the present Wood creek and the drainage west and northwest of Rome.

In tracing the history of these drainage systems, Fairchild (*ibid.*) came to the belief that the present north-flowing obsequent tributaries of the Mohawk were a part of the Susquehanna system, with headwaters far to the north of the present divide heading far up on the southern slopes of the Adirondacks; but just where these headwaters were located has not been definitely established. This consequent drainage was not to last long, however, because of the eastward and westward extension of the Ontarian-Mississippian and Mohawk-Hudson headwaters to the Little Falls region, thus beheading and absorbing through piracy the headwaters of the Susquehanna and causing a southward migration of the divide as well as a reversal of the drainage in preglacial times. These Tertiary events, which were probably many thousands of years in development, were followed by Pleistocene time, during which, with the great thickness of ice and consequent constructive and destructive abrasive effects, as well as the effects of the tremendous volumes of water derived from the melting ice, great changes were wrought in the development of these drainage systems. Not only were the west and east-flowing rivers which headed at Little Falls united through lowering of this divide by glacial waters but changes in the directions and courses of some of the tributaries of the Mohawk were brought about, as we shall see later.

Involved in such a varied history, the present drainage systems reflect not only the underlying major geologic structures and the topography, but also the many changes in their origin. Such a history is seen in the pattern of the streams. This is of the trellis type so far as the major streams and their tributary junctures are concerned, but for most of the other streams in this area, acute angled accordance for tributary junctures characterize the drainage pattern. Ruedemann's tangential master streams (1931, p. 431-40) with their characteristic glint drainage have undoubtedly played a large part in the development of the Mohawk Valley region.

The Mohawk as a subsequent stream to the Hudson in postglacial time now shows many of the characteristics of old age, particularly as reflected in its low gradient of three feet to a mile between Rome and Utica and its consequent meandering.

The Oriskany as an obsequent stream of the Hudson-Mohawk system and one of preglacial origin, as evidenced by the amount of glacial gravels and sand along its course, has much work to do before it can cut its bed down to the level of the Mohawk, as can be seen in its gradient of 39.2 feet a mile throughout a course of 29.2 miles. For the 16 miles of its course represented in the Oriskany area its gradient is 17 feet to a mile, and the longer part of this, from Franklin Springs north, is through glacial gravel, clays and sands, the product of melt-waters and their descendant rivers.

The constriction of the valley at the "Dugway," just south of Franklin Springs, is caused by the river cutting through the Niagaran and Vernon shales. This part of the river's course may possibly be postglacial in origin, in contrast with the wide valley to the west beyond the Vernon outlier through which the New York, Ontario and Western Railway passes. Sufficient damming by ice or morainal debris to the south of the "Dugway" could very well have initiated the present course of the Oriskany creek, but there is no evidence of such a dam today.

The source of the Oriskany is traceable to springs and swamps in the Devonian rocks a few miles to the north of Bouckville, just north of the divide, from whence it flows south for a short distance and then northeast through Oriskany Falls and Deansboro, emptying into the Mohawk at the village of Oriskany just nine miles north of Clinton.

GROUND WATER

The variety of rocks and soil, climate, amount of vegetation, and slope are some of the most important factors which determine the amount of rainfall absorbed by the ground, or ground water, and the amount constituting the runoff.

Even within such a small area as the Oriskany quadrangle, where there are nearly 18 different kinds of soil, a variety of rock formations, including nearly 2000 feet of shale and 200 to 300 feet of limestone, and a rolling topography trenched by an important river and two tributaries, we should expect varying amounts of runoff and absorption. Certainly the depth to the water table in a nonglaciated country would vary directly with the amount of precipitation. In dry years such as this district experienced in 1933-34, the water table was abnormally low, a fact which was reflected in all reservoirs and wells directly dependent upon ground water supply. Many wells, never dry before 1933, went dry in that year; and they did not come back to their normal depth until 1936-37. In general, when penetrating only the soil and drift, we should expect very different ground water conditions than prevail in the underlying rocks. Not only do the glacial deposits differ as to their water-holding capacity—gravels and sands, for instance, possessing a much higher porosity than glacial till; but they differ also as to variety, thickness, and distribution. The rocks likewise differ as to their water-holding capacity, limestones and sandstones being considered far better aquifers than shale.

On the Hamilton College campus and in the Oriskany valley are found certain illustrations of the conditions referred to above. From the north end of the campus of the college, five feet below the surface, to the southern end at a depth of 18 feet, is a southerly pitching, wedge-shaped, undulatory body of quicksand intercalated with glacial till above and below, with the Vernon shale underlying these deposits. This body of quicksand has had to be taken into consideration in the construction of college buildings. As the glacial till above and below the body of quicksand is relatively impervious, one wonders how the quicksand maintains its highly aqueous condition, except for some connection with the surface. A well on the campus, near the administration building, has a depth of 23 feet to the Vernon shale, and it undoubtedly passes through this body, possibly deriving some of its supply of water from it, as well as from the contact of the till with the Vernon shale.

The Hamilton College water supply, which is located two miles southwest of the college, consists of three reservoirs with a total capacity of 27,000,000 cubic feet. The source of the water stored in these reservoirs comes from a spring near the most western one at approximately the 1200-foot contour, near the contact of the Camillus with the Vernon. At the head of the lowest reservoir, calcareous tufa is being precipitated as a lime mud, due to the oxidation of the bicarbonate of lime $Ca(HCO_3)_2$. According to an analysis by A. P. Saunders the hardness of the college water supply before the addition of the new reservoirs was as follows: $CaCo_3$, 56.1 parts per 100,000.

At the head of the Clinton water supply, voluminous springs of lime-charged water issue out of rectangular, tunnel-like openings a few inches in diameter in the Camillus. From the size of the deposits of calcareous tufa found in this area near the springs one is impressed by the great solubility of the Camillus formation. The amount of tufa, which is locally known as "horse bone," found in the Oriskany area, especially along tributaries on the east and west slopes of the valley, testifies further to the fact that the Camillus is one of the most soluble if not the most important water-bearing formations of the area.

The effect of rains upon the water level in the college reservoirs is not felt until six weeks after the heavy rains, and this effect is due mostly to ground water rather than to runoff since no surface streams flow into the reservoirs.

Undoubtedly some of the tributaries of the Oriskany have their source in the Camillus. Other limestone formations, such as the Manlius and the Coeymans, initiate important tributaries in their ground waters such as White creek, which empties into the Oriskany at Franklin Springs. The limestone quarries of Frank Cittadino on Paris hill are believed to be the source of that creek, though important contributions are made from the underlying calcareous formations. The following analyses, taken from the "Report on Proposed New Source of Water Supply for the Village of Clinton, N. Y." by Solomon and Keis, consulting engineers, Troy, N. Y., testify to the calcareous nature of some of the formations underlying the tributaries of the Oriskany:

Water analyses

STREAM	CHEMIST	DATE	HARDNESS
Miller brook	W. H. Wilson	May 10, 1920	326
Miller brook	W. H. Wilson	Nov. 4, 1920	625
Miller brook	J. M. Caird	Oct. 7, 1933	1 064
White creek	W. H. Wilson	May 10, 1920	222
White creek	W. H. Wilson	Nov. 4, 1920	369
White creek	J. M. Caird	Oct. 7, 1933	598.5
Ely brook	J. M. Caird	Oct. 7, 1933	1 463
Deansboro brook	J. M. Caird	Oct. 7, 1933	997.5
Beatty brook	J. M. Caird	Oct. 7, 1933	558.6
Oriskany creek	J. M. Caird	Oct. 7, 1933	399

Water analyses
by James M. Caird
Chemist and bacteriologist
October 13, 1933

	ELY BROOK	CLINTON RESERVOIR	DEANSBORO CREEK	WHITE CREEK	BEATTY BROOK	ORISKANY CREEK
Total solids....	2 035.0	1 400.0	1 275.0	620.0	600.0	420.0
Loss on ignition........	300.0	430.0	340.0	130.0	135.0	115.0
Hardness......	1 463.0	1 064.0	997.5	598.5	558.6	399.0
Alkalinity.....	192.0	200.0	224.0	188.0	188.0	260.0
Chlorides......	14.0	15.0	9.0	12.0	6.0	6.0
Iron..........	.2	.4	.4	trace	.05	.2
Phosphorus....	7.6	7.8	7.6	7.8	7.8	7.8

The wells in this area are of the driven, dug or the drilled variety. The depth to the bedrock for some of the more important ones, as furnished by the late J. H. Foley of Utica is given below. The depth to bedrock is greatest along the Mohawk valley, where Mr Foley has driven several wells. At the Utica Gas and Electric plant, in west Utica, a hole was put down 155 feet to hardpan, most of this depth being through quicksand. Generally the depth to bedrock along the Mohawk between Utica and Little Falls is about 150 feet. Depths of 70 and 105 feet have been reported in Rome. On College hill Elihu Root's well was driven 134 feet to bedrock, where water with magnesium salts was found, which makes the water unfit for drinking.

At the Clinton canning factory in the village of that name, a well with a four-inch casing was drilled to a depth of 86 feet, and although it was only 35 feet to bedrock, water was found at a depth of 80 feet. This supply gave a stream one and one-half inches in diameter, but the water is heavy with sulfides and some chlorides according to the operators of the canning factory.

A well on the Eisler farm south of Prospect hill has a depth of 90 feet to bedrock. The water is hard and the well has never been known to go dry.

The J. Pierpont White well on Crow hill was drilled a considerable distance through rock, and an inadequate supply of water was reported to have been found 300 feet below the surface.

Some of the wells of the driven or dug variety go down as far as 80 feet, and in the great range of depths obtained, these wells have been found to be generally very sensitive to dry and wet seasons, the water level depending upon precipitation and the water-bearing bed.

Some of the local springs appear to have an unusual composition, as seen in the Clinton lithia springs situated in the Oriskany valley south of Franklin Springs. The well which gives rise to these so-called springs penetrates bedrock at about 24 feet, and passes through the Clinton formation at a depth of 67 feet, yielding, besides CH_4, the following substances as determined by the United States Bureau of Chemistry:

Compounds	Parts per Million
NH_4Cl	30.30
$LiCl$	16.91
KCl	42.36
KBr	29.05
KI	0.10
$NaCl$	4796.06
$MgCl_2$	178.71
$CaCl_2$	59.30
$CaSO_4$	15.88
$Ca(HCO_3)_2$	348.33
Fe_2O_3	3.20
SiO_2	12.60

It is not difficult to account for most of the constituents in the above analysis, but the origin of chloride of lithia seems to be an enigma. This water, compared to that of Camillus-derived springs, referred to on previous pages, is relatively soft (see table below). The Halleck spring in Westmoreland according to the analysis of Professor J. Noyes, formerly of Hamilton College, shows the following composition:

Compounds	Grains
$NaCl$	78.00
$CaCl_2$	13.00
$MgCl_2$	4.00
$CaSO_4$	5.00
	100.00

The Halleck spring water was originally devoted to commercial purposes. It can now be identified by gas bubbles issuing from the middle of a tributary of Deans creek, which flows to the southeast, one mile northeast of Westmoreland. This shows the presence of a certain amount of methane. The spring now flows from a boring made 102 years ago into 106 feet of rock. The water has a distinctly saline taste, and it was bottled by an organization known as the Halleck Mineral Springs, which used a three-story bottling works (see Beck, 1842, p. 140). The springs issue from the Frankfort formation.

GENERAL GEOLOGY

The Oriskany quadrangle is underlain entirely by sedimentary rocks of the Lower and Middle Paleozoic era. From north to south they are found to belong to the Ordovician, Silurian and Devonian systems with a covering of Pleistocene deposits over the interstream areas and of recent flood-plain deposits adjacent to the river courses. The rocks are predominantly shales, limestones, dolomites and sandstones, with several intercalated beds of iron ore. The varied lithology, paleontology and stratigraphy of these rocks as well as the many problems arising from them have long engaged the attention of geologists.

In its relatively simple homoclinal nature, as represented in the Allegheny cuesta, with a few interesting departures from this simple structure, it would appear that this region is worthy of description as structurally representative of east central New York.

Though much has been written of the Clinton, Utica and Vernon formations, and to a lesser extent of others in this same general region, likewise in type localities, it has seemed worth while to assemble the important information now scattered throughout the literature and to add whatever new facts have been brought to light in this study. The main facts regarding these formations from the oldest to the most recent are presented on the following pages.

ORDOVICIAN SYSTEM

The Utica and Frankfort formations comprise the Cincinnatian division of the Ordovician, and these, the oldest formations on the sheet, underlie a third of this quadrangle. Although the Cincinnatian has its best development in Ohio and Indiana, it nevertheless plays an important part in the stratigraphic sequence of central New York.

Utica Shale

The Utica shale, which is the oldest of the Ordovician rocks in this area, is black and gray, slightly fissile to massive with intercalated lentils of massive calcareous argillite. It derives its name from the city of Utica with typical exposures at either the Ballow creek or Starch Factory creek east of the city of Utica. Doctor Ruedemann (1925a, p. 32) believes that Ballow creek, now no longer accessible, served as the type locality for Vanuxem in 1842.

Summary of sedimentary formations of the Oriskany quadrangle

Postglacial Holocene Deposits			Soil, talus, swamp, spring (tufa), lake and river deposits (gravels and sands). Some plant remains. No extinct forms of mammalian life as yet found. Unconformable upon all older deposits.
Quaternary Pleistocene	Aqueoglacial Deposits		Gravels, sands and clays of eskers, kames, outwash plains and deltas. Sands and clays of proglacial lakes. All deposits are stratified. Unconformable on all older deposits. No contemporary fossils found on the Oriskany quadrangle.
	Glacial Deposits		Boulders, glacial till and quicksand. Unconformable upon all older deposits.
Devonian	Helderbergian	Coeymans	Coarse crystalline limestone with corals, crinoids and trilobite pygidia.
Silurian	Cayugan	Manlius group: Jamesville	Dark blue fossil limestone with fissile dark shale partings, nodular; corals, stromatoporoids, brachiopods, crinoids, pelecypods, ostracods and gastropods.
		Clark Reservation	Compact blue limestone with ostracods (Leperditias).
		Olney	Mottled blue and drab limestone, thin-bedded, ringing sound. Stropheodonta varistriata, Spirifer vanuxemi, Leperditia alta.
		Salina beds: Bertie waterlime	Drab-colored, thin-bedded, clayey limestones with mud cracks, worm tracks, corals and eurypterids.
		Camillus	Mottled red and green, drab-colored shale. Thin-bedded waterlime zones with salt hopper casts and brecciated zones.
		Vernon	Red shale with stratiform zones with green spots, green shale and waterlime (carbonaceous).
		Pittsford	Dark-colored shales with dolomite beds carrying seaweeds and eurypterids.

Summary of sedimentary formations of the Oriskany quadrangle (*concluded*)

Silurian (*concluded*)	Niagaran	Lockport	Dark-colored shales with stromatoporoid reefs and edgewise conglomerate. Dolomite.
		Clinton beds: Upper	Herkimer sandy dolomite and shale with red flux (hematitic bryozoan reef of Rochester age) Paraechima spinosa zone. Very fossiliferous.
		Middle	Willowvale or Williamson green shales with fossiliferous, dolomitic lentils. One main oölitic hematite zone at base and lean zone above; red flux also. Sauquoit green shales with dolomitic, sandy and conglomerate beds.
		Lower or Oneida conglomerate	Quartz pebble conglomerate and cross-bedded sandstone, pyritiferous. Arthrophycus alleghaniensis.
Ordovician	Cincinnatian	Lorraine beds: Pulaski	Sandy shales and sandstones. Crinoids and brachiopods, Rafinisquina mucronata.
		Frankfort	Gray sandy shales and sandy dolomites with graptolites, brachiopods and trilobites (pyritized).
		Utica: Upper	Dark carbonaceous shale with calcareous argillites. Climacograptus pygmaeus.
		Lower	Dark carbonaceous shales with calcareous argillites. Climacograptus typicalis, Triarthrus eatoni and Geisonoceras.

Since the initial study, much intensive investigation has been carried on by skilled geologists among whom may be cited: Hall, 1865; Prosser, 1890; Walcott, 1890; Ruedemann, 1904, 1908, 1911, 1925a; Ulrich, 1911; Clarke and Schuchert, 1915; Twenhofel, 1915; Foerster, 1916; Raymond, 1916; Grabau and O'Connell, 1917; and Bassler, 1919.

The formation assumes a gray color near its contact with the overlying Frankfort. So far as can be determined in this study, the contact appears to be gradational rather than sharp.

Referring to Doctor Ruedemann's Otsquago and Nowadaga-Ohisa creek sections, which are the only complete ones in the Mohawk valley including the Utica shale, it is seen (1925a, p. 31) that he distinguishes three zones for the Utica. Furthermore, if 300 or 400 feet are allowed for the thickness of the upper Utica which represents the thickness at Holland Patent, and if the 250 feet of the Utica exposed at Starch Factory creek belongs to the Upper Utica, then it is apparent that the only Utica found in the Oriskany quadrangle must be the Upper Utica with the Mohawk river serving as the surface boundary line between the Utica and the Frankfort (see map). Due to the scarcity of exposures with abundant fossils it was not possible for the writer to confirm this point precisely. An unaccountable thinning of the Utica takes place between Holland Patent and Floyd. The writer believes, however, that this apparent thinning may be due to a north-south normal fault between Holland Patent and Floyd with a consequent lowering of the Utica-Frankfort contact to about 140 feet. Evidence for this structure will be presented under the section dealing with structural geology.

The exposures of Utica shale are largely confined to the north side of the Mohawk river, but even here there are only very insignificant exposures between Floyd and Six Mile creek.

It is relatively difficult to ascertain the thickness of a shale formation which is very fissile and which weathers by checking. Due to this lack of any continuous bedding plane, it is impossible to obtain many dip readings. The only dip observations obtainable for the Utica and Frankfort were either at a contact of the overlying Frankfort and the overlying Oneida or within the Frankfort itself from sandy or dolomitic beds of large exposure. Such beds gave dips of 4°-5° to the southwest. If a uniform dip of 5° is used to calculate the thickness as exposed between Holland Patent and the Mohawk of the Utica, it would amount to nearly 311 feet. With the Trenton in contact with the Utica to the east of Holland Patent in anticlinal structure the above estimated thickness could hardly hold for the Utica exposed between Holland Patent and the Mohawk.

Ruedemann (1925a, p. 35) estimates that ". . . the thickness of the upper division of the Utica, that alone is present at Holland Patent, is between 300 and 400 feet." In making estimates it is necessary to consider an overlap, the folded condition of the underlying Trenton, and the marked thinning of the Utica in the Holland Patent and Floyd region at the same time, thus making it a complex problem.

Conditions of sedimentation. Two subordinate basins of Ordovician deposition occur in New York, one of which, the western, involves some of the sediments with which we are concerned and an eastern one situated in the Schenectady region. The western basin consists of several hundred feet of Trenton limestone followed by a transition zone between it and the Utica known as the Dolgeville beds and consisting of an alternation of carbonaceous shales and calcareous argillites. These are followed by some 700 or 800 feet of Utica shale. All these beds were deposited in the Trenton basin while farther east is found the Schenectady basin in which occur a preponderant thickness of dark shales comprising the Canajoharie and the Schenectady beds with no limestone of the Trenton formation. The difference in the character of sedimentation of the two basins lies largely in this preponderance of the dark shales in the eastern basin and the presence of a considerable amount of limestone of the Trenton formation in the western basin. According to Ruedemann (1925a, p. 73):

. . . the difference consisted solely in the absence or scarcity of terrigenous mud in the Trenton sea and its overwhelming influx in the Utica and Canajoharie waters; first in a succession of short invasions, after each of which the former, congenial lime-making condition of the Trenton sea was restored with its flourishing corals, bryozoans, brachiopods and other animals that require purer water for their existence. Every black shale influx brought with it the graptolites and a characteristic black shale faunule.

Such a lateral difference in sediments could be attributed to the deepening of one basin westward or to two basins, each of which received a different kind of deposit. According to Ruedemann (*ibid.*):

The evidence from their gradual replacing by alternation the limestone making conditions of the Trenton sea with its abundance of life is clearly that they were deposited in the same epicontinental sea and at the same depth as the limestone, but that conditions had arisen which produced the influx of great masses of mud in the east pointing to an eastern source of the black mud. This is to be sought in the elevated region to the east (Taconia of Schuchert), where a sufficient drainage had developed to supply the eastern marginal sea with the terrigenous mud which was picked up by circulatory currents of the sea and gradually spread westward in ever thinning layers. The presence of such currents has been suggested before by the writer (Ruedemann, 1897).

As is well known this evidence is seen in the parallel alignment of the graptolites.

Ruedemann has also observed in the fine texture of the Utica as well as in that of the Canajoharie and Deer River beds the absence of sandstone, conglomerates, ripple-marks, sun cracks or cross beddings, some of which are found in the Frankfort and most certainly in the Schenectady beds; and furthermore the black shale of these formations is replaced shoreward by the Schenectady beds, that is, shales and intercalated sandstones. This would indicate that these black shales are the result of the deposition of mud that was carried out to sea considerably beyond the littoral zone, and also that it was deposited in relatively quiet water.

Origin. In a recent paper Ruedemann (1935, p. 79-91) concluded that shales like the Utica "indicate by their contained faunas and lithologic associations the prevalence of somewhat abnormal toxic bottom conditions that either impoverish or completely prevent all bottom life. It is further evident in practically all our cases of Paleozoic black mud shales that the deposition was not restricted to small areas or regions or so restricted in thickness that it could have taken place in small embayments and lagoons, or on deltas, as is claimed by some, but requires for explanation the existence of the conditions of the production of black muds over vast areas and throughout long intervals of time. Such requirements could be fulfilled, in our view only at the deeper levels of the littoral regions, as Lapworth concluded some sixty years ago, or at the bottom of troughs (Levis and Chazy) of the Appalachian geosyncline."

For further information concerning the environment of the Utica shale the reader is referred to the writings of Ruedemann (1925a).

Paleontology. The most important of the fossils of the Utica shale are the graptolites, which, because of their zonal distribution, have long been used to subdivide the Utica into its three graptolite zones, with the two additional ones for the Atwater Creek and Deer River shales farther to the northwest. The three zones which characterize the Utica shale are: (1) zone of *Climacograptus pygmaeus* and *Glossograptus quadrimucronatus timidus*, (2) zone of *Dicranograptus nicholsoni* and (3) zone of *Climacograptus typicalis* and *Glossograptus quadrimucronatus approximatus*.

So far as known at present, only the upper one of the three zones is represented in the Oriskany area, the zone of *Climacograptus typicalis* and *Glossograptus quadrimucronatus*. In the middle and upper Mohawk valley the three zones are: (1) zone of *Climacograptus typicalis*. (Ruedemann, 1908, p. 154). This includes the zone of *Glossograptus quadrimucronatus approximatus* and *Lasiograptus eucharis*, (2) zone of *Dicranograptus nicholsoni* (*ibid.*, p. 528) and (3) zone of *Climacograptus pygmaeus* and *Glossograptus quadrimucronatus timidus*.

According to Ruedemann, zone three, characterized by *Climacograptus pygmaeus* and *Glossograptus quadrimucronatus*, measures

150 feet in thickness in the Utica district, with 50 feet of transitional Frankfort. Quite apart from the paleontologic and stratigraphic importance of the graptolites in the Utica formation, it is well to note that 74 species of fossils are reported by Walcott and

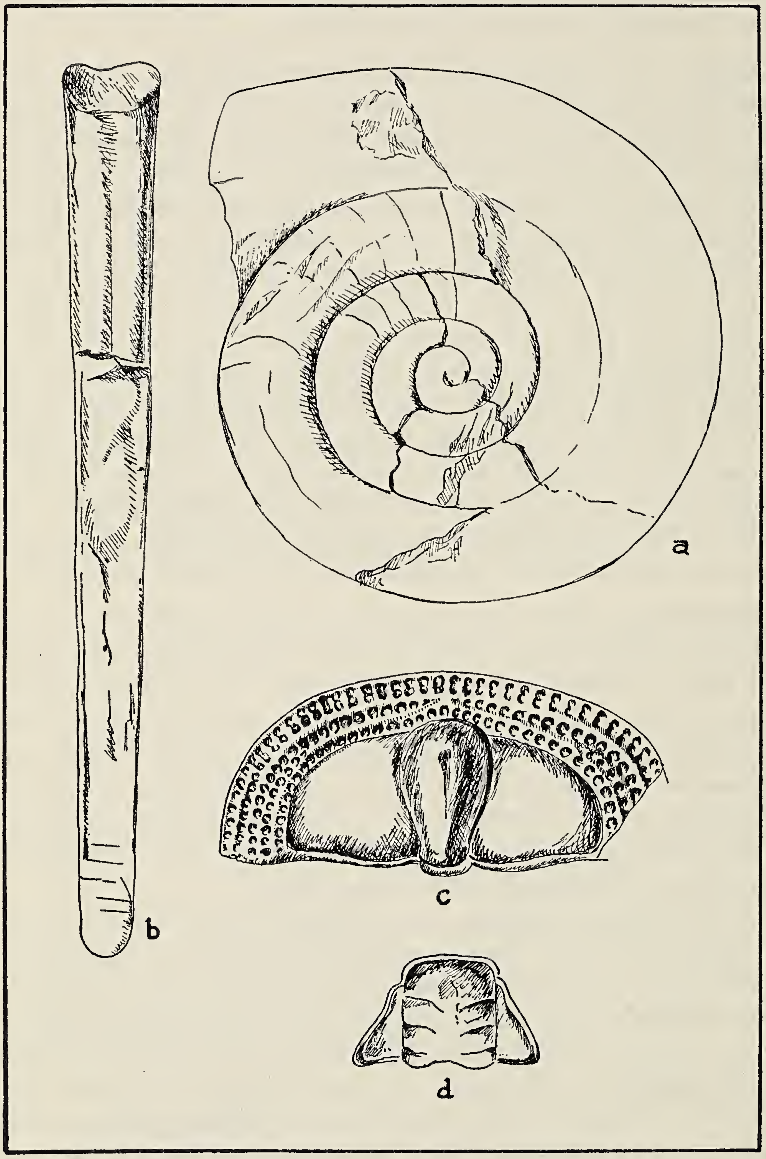


Figure 5 Frankfort and Utica fossils. (Cephalopods *a, b;* trilobites *c, d*). *a Trocholites ammonius* var. major, x 10. *b "Geisonoceras" amplicameratum,* x 2. *c Cryptolithus bellulus,* x 5. *d Triarthrus eatoni,* x 2. (Original drawings by V. Caldwell)

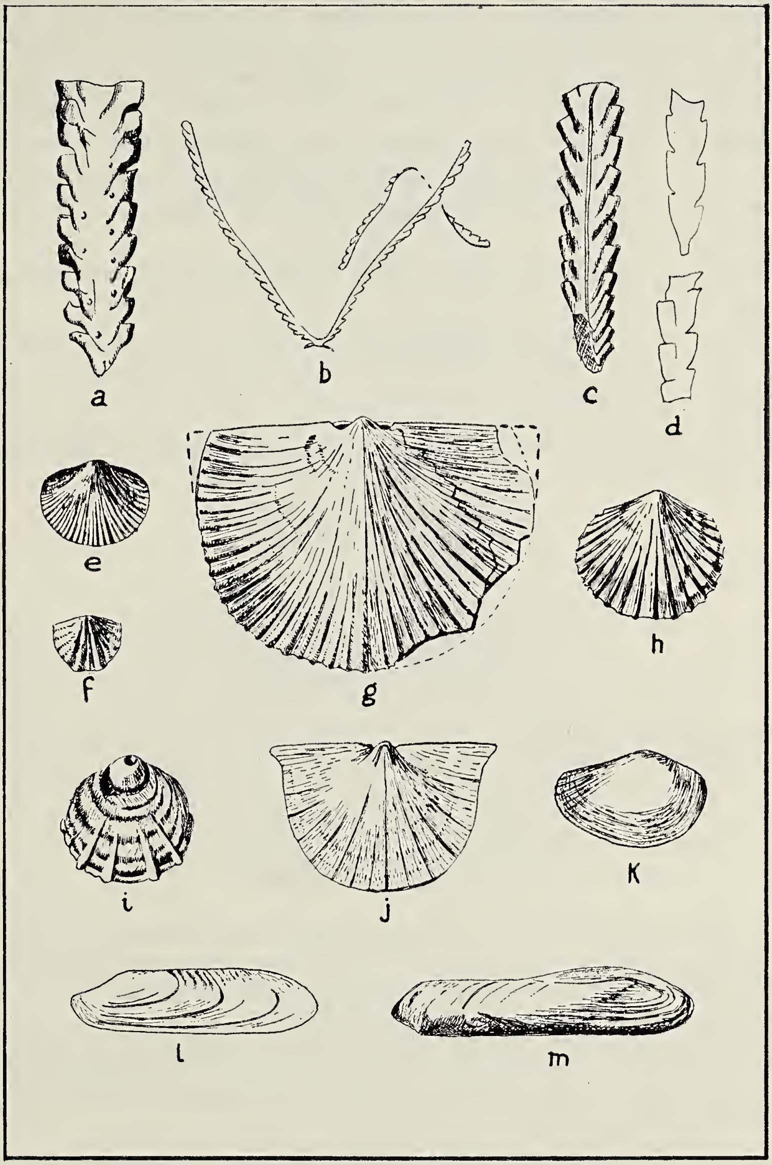


Figure 6 Frankfort and Utica fossils. (Graptolites *a-d;* brachiopods *e-k;* pelecypods *l, m*). *a Climacograptus typicalis,* x 10; *b Leptograptus annectans; c, d Climacograptus putillus,* x 12; *e Dalmanella multisecta; f Zygospira concentrica; g Rafinesquina alternata mut. centrostriata; h Camarotoechia (?) humilis,* x 2; *i Leptobolus insignis mut. latus,* x 7; *j Lyrodesma conradi; k Rafinesquina mucronata,* x 2; *l Cymatomata parallela; m C. pholadis.* (Drawn by V. Caldwell)

others including three algae, nine sponges, 14 graptolites, 23 hydrozoans, three bryozoans, seven brachiopods, five worms, two conularids, four pelecypods, two gastropods, 10 cephalopods, five trilobites, two ostracods, one phyllocarid, one cirripedian, and six eurypterids. The full list comprises a typical Utica fauna, but it belongs to the upper division of the Utica and represents the results of collections made by Rust, Walcott and Haskell. The collections are known as the Rust and Haskell collections of the New York State Museum and the United States National Museum respectively (see figures 5, 6).

Some of the characteristic fossils of the important localities are listed below.

Maynard Creek section, Marcy, N. Y. This section was observed by Ruedemann (1925a, p. 39, 40) along Maynard creek, one and one-half miles north of Utica. He states:

The section affords a practically continuous outcrop of black shale through 150 feet of rock. At the base are found:

Climacograptus typicalis Hall and
Triarthrus eatoni (Hall)

Thirty feet higher up there appear:

Leptograptus annectans (Walcott) mut.
Climacograptus typicalis Hall
Climacograptus pygmaeus nov.
Leptobolus insignis Hall
Triarthrus eatoni (Hall)

Leptograptus annectans can be traced as a rather frequent graptolite through 30 feet of black shale, and with it occur:

Mastigograptus tenuiramosus (Walcott) r
Climacograptus pygmaeus nov. cc
Leptobolus insignis Hall r
Geisonoceras tenuistriatum (Hall)
Triarthrus eatoni (Hall) c

In the remaining 90 feet of the section only *Climacograptus pygmaeus* was found, but in immense numbers. This upper shale with *Climacograptus pygmaeus* can be traced in adjoining creeks into the Frankfort beds that cap the Deerfield range.

It is obvious that in this section only the uppermost Utica with *Climacograptus pygmaeus* is exposed. The more remarkable then is the continuance of *Leptograptus annectans* together with *Mastigograptus tenuiramosus.*

Section along Marcy creek, Oneida county, N. Y. Three and one-half miles northwest of Maynard creek is the section of Marcy creek which in former years has furnished a number of the rarer Utica fossils. It also extends to the level of the Mohawk river and thus completes the Maynard section.

The whole 140 feet of almost continuous section exposed along the creek from the neighborhood of the Marcy railroad station down to its entrance into the flood plain of the Mohawk river is within the upper zone.

In the lowest outcrops, at station 3, above and below the bridge of the Utica-Rome highway *Climacograptus pygmaeus* and *Leptobolus insignis* were found, the first in great abundance.

At station 2, 20-40 feet higher up, and about the lower end of the gorge of Marcy creek, there occur in thick-bedded black mud shale:

Sphenophycus lobatus nov. rr
Sphaerodictya subsphaerica (Walcott) rr
Leptograptus annectans (Walcott) r
Climacograptus pygmaeus nov. cc
C. typicalis Hall r
Leptobolus insignis Hall c
Camarotoechia (?) *humilis* nov.
Dalmanella sp.cf. testudinaria (Dalman) (small specimens) r
Endoceras sp. (fragments)
Triarthrus eatoni (Hall) c
Eurypterid fragments

The remainder of the section through the ravine and as far up as the railroad bridge below Marcy station furnished in heavy bedded black shale:

Climacograptus pygmaeus nov. cc
C. typicalis Hall r
Leptobolus insignis Hall r
Schizocrania filosa Hall c
Endoceras sp. r
Triarthrus eatoni (Hall) c

It is obvious, from the sections in the city of Utica and the two sections just described north of the Mohawk, in the town of Deerfield, that in the immediate neighborhood of Utica only the uppermost division of the Utica shale is exposed in the Mohawk valley.

Summary of sections east and north of Utica. A survey of the Utica sections thus far recorded indicates that there are three major graptolite zones developed in the Utica shale of the middle Mohawk valley and the Utica region. These are, in descending order:

3 Zone of *Climacograptus pygmaeus* and *Glossograptus quadrimucronatus timidus*

2 Zone of *Dicranograptus nicholsoni*

1 Zone of *Climacograptus typicalis, Glossograptus quadrimucronatus approximatus,* and *Lasiograptus eucharis*

Of these three zones, the lowermost appears to be the thickest in the Mohawk Valley below Utica. It reaches 500 feet in the Otsquago creek section, and is probably as much in the Utica section.

The second zone, that of *Dicranograptus nicholsoni,* is known only from the Otsquago and Ohisa sections where it may reach 170 feet.

Of the third zone, nearly 200 feet are exposed in the Starch Factory creek section and the bottom not shown.

Sections West and North of Utica

Six Mile creek, about 7½ miles west of Holland Patent. At this locality, which became famous through the discovery, by Valiant, of the pyritized specimens of *Triarthrus eatoni,* retaining the appendages, and described by Beecher, the base of the section contains *Climacograptus typicalis, Glossograptus quadrimucronatus approximatus* and *Triarthrus eatoni,* while the succeeding 100 feet that are exposed contain first *Climacograptus typicalis,* often in great numbers together with *Leptobolus insignis* etc., and finally *Climacograptus pygmaeus* as diagnostic species. In lithologic character, all the beds, except the lowest exposure, are transitional to the Frankfort and the occurrence of the pyritized Triarthrus is in a bed of black shale, intercalated in gray argillaceous shale of Frankfort appearance. (*ibid. p.* 41)

If by the Six Mile Creek locality is meant any of the localities west of Holland Patent within the distance indicated, the writer is of the opinion that these sections, at least those just west of Floyd, partake more of the character of Ruedemann's upper zone if not of the Frankfort for the reasons given below.

Just west of Floyd are two abandoned road metal quarries, the first one measuring 100 by 75 by 10 feet, the more western one measuring 100 by 20 by 20 feet. These sections are made up largely of dark gray lustrous shale, with thin lentils of cross-bedded dolomitic sandstones, three to four inches thick and containing pyritized heads of *Triarthrus eatoni, Geisonoceras* sp., *Camarotoechia humilis* and *Climacograptus* sp. These observations apply to the first quarry. while in the second we find pyritized *Triarthrus eatoni* heads and *Leptobolus insignis.* In both localities the fossils are found associated with the sandy dolomitic lentils. Due to the deeply weathered condition of the shale, it is not possible to collect fresh samples.

From a lithologic standpoint these exposures resemble the Frankfort far more closely than they do the Utica, since such characteristics as the dark gray color and the cross-bedded nature of the sandy lentils are altogether lacking in the Utica. From east to west along the Mohawk valley there appears to be, according to Ruedemann (1925a, p. 53) "progressively overlapping series in the continuous belt of black shale extending from the mouth of the Mohawk to that of the Black river, the oldest zones being in the southeast, at the lower Mohawk, and the youngest in the northwest, at the lower Black river."

Lorraine Beds

Both the Frankfort and Pulaski formations, which comprise the Lorraine beds, are found on this sheet. The name "Lorraine" was derived from the village of that name in Jefferson county (Emmons, 1842) and was originally used for all the beds above the supposed Utica in northwestern New York State, the Frankfort not being recognized at that time by Emmons.

Figure 7 Disconformity between the Frankfort and Oneida formations. Ledge at base of falls is Oneida conglomerate. Mallory Creek. (Photograph by D. R. Meredith)

Frankfort shale. Overlying the Utica transitionally is a series of thick dark and light gray weathered sandy shales with thin beds of dolomite. The whole series measures approximately 300 feet in thickness. The exact thickness of this formation is difficult to ascertain because of the buried contacts and gradational relations with the underlying Utica. The formation was given its name by Vanuxem in 1840 from the typical and excellent exposures along Moyer creek, southwest of Frankfort in Herkimer county, where the formation shows an unconformable contact with the overlying Oneida conglomerate (see figure 7).

As is shown on the areal map (map 1), the Frankfort composes the major portion of the hills north and west of Floyd and northeast of Marcy, while a strip 12 miles long by six miles wide is underlain by it on the south side of the Mohawk. The best exposures are generally found in the stream cuts along the inface slope of the cuesta or along the sections made by the south-flowing tributaries of Six Mile creek. Several excellent exposures of the Frankfort are found west of Floyd, northeast of Westmoreland and northeast of Clinton to which reference has already been made. The two latter localities are excellent collecting grounds.

In Mallory brook, a northwest flowing tributary of Sauquoit creek, one mile southeast of Washington Mills and an equal distance northeast from Willowvale, the Frankfort and the Oneida are in contact with the Pulaski and the Oswego formations missing (figure 7). According to Goldring (1931, p. 290), "The Frankfort beds attain their greatest development in the Utica basin, where they have a thickness of about 500 feet." In a recent well drilled for gas near North Brookfield, 20 miles southeast of Clinton, the thickness of the gray shale element, which is presumably Frankfort, is 377 feet. The fauna of the Frankfort resembles that of the Utica much more closely than it does that of the overlying Pulaski. Some of the outstanding representatives of the fauna west of Floyd, where the rock is a medium to dark gray sericitic and calcareous shale with thin calcareous sandy beds intercalated, are as follows:

Graptolites
Climacograptus typicalis (Hall)
Brachiopods
Crania laelia Hall
Delmanella multisecta (Meek)
Leptobolus insignis (Hall)
Orbiculoidea tenuistriata Ulrich
Rhytimya sp.
Zygospira cincinnatiensis Meek

Pelecypods
Pterina insueta (Emmons)
Cephalopods
Geisonoceras amplicameratum (Hall)
Trocholites ammonius (Conrad)
Trilobites
Triarthrus eatoni (Hall)
Cryptolithus bellulus (Ulrich) (pyritized)
Homotelus stegops (Green)

Westmoreland section. This section lies along several of the southeast-flowing tributaries of the Oriskany, half a mile to the northeast of Westmoreland on the Charles Graves property, which is the site of Halleck springs. The rock is dominantly a grayish shale with thin beds of argillaceous and pyritiferous sandy dolomite or calcareous sandstone, in which the quartz and calcite grains are in approximately equal amounts. The sections as seen here are found along the bed of the stream and on the sharp banks.

The fauna which is generally found on the surfaces of the sandy dolomite beds shows the following species, thus far identified:

Graptolites
Climacograptus typicalis (Hall)
Crinoids
Crinoid crown, sections and columnals
Bryozoans
Bythopora arctipora (Nicholson)
Brachiopods
Camarotoechia ? humilis Rued.
Dalmanella multisecta Meek
Orbiculoidea tenuistriata Ulrich
Rafinesquina alternata (Emmons)
Zygospira concentrica Ulrich

Pelecypods
Cymatonota parellela (Hall)
Lyrodesma conradi Ulrich
Rhytima sp.
Gastropods
Archinacella subcarinata Rued.
Cephalopods
Geisonoceras amplicameratum (Hall)
Trilobites
Cryptolithus bellulus (Ulrich)

Clinton-Mud Creek section. From a mile to a mile and a quarter east of the village of Clinton along a north and northeasterly flowing tributary of Mud creek, which is itself a tributary of Sauquoit creek, is a 20-foot section of the Frankfort overlain by the Oneida, although the contact was concealed at time of visit. Here the Frankfort is not unlike that of other localities heretofore described, as it is mostly a thin, brown, weathering gray, sandy shale with calcareous and micaceous sandy layers. These sandstones are somewhat argillaceous and the mica appears on the bedding planes. None of the dark carbonaceous shales, which are so characteristic of the Utica and to a less extent of certain doubtful Frankfort occurrences, are found here. In other words, this locality more closely resembles the Westmoreland section and other sections south of Utica. The fauna found here is as follows:

Sea weed
Buthotrephis sp.
Graptolites
Climacograptus typicalis (Hall)
Crinoids
Crinoid crown, sections and columnals
Schizocrinus nodosus Hall

Brachiopods
Camarotoechia (?) *humilis* Rued.
Pelecypods
Modiolopsis ovata (Conrad)
Gastropods
Archinacella subcarinata Rued.
Trilobites
Homotelus stegops (Green)
Proetus beecheri, Rued. (*pygidium*)

Pulaski shale. The upper member of the Lorraine is represented by the lower part of the Pulaski as can be seen in an abandoned quarry creek, now a swimming hole in the Spencer Settlement stone quarry, three and one-half miles south of Rome and five miles northwest of Westmoreland. The thickness here is undetermined, but probably less than ten feet.

As is well known, the Pulaski shale received its name (Vanuxem) from the village of Pulaski, Oswego county, along the Salmon river. In this area, as in the Salmon River district, the rocks appear as a brown weathering gray shaly sandstone, which is somewhat calcareous and pyritiferous, with disseminated sericite on the bedding planes. Some of the thinner strata are characterized by shaly conglomerates, resembling thon-gallen, or interformational conglomerates, the shaly fragments dominating some of the more sandy beds. No relations with the over or underlying beds were observed. Some of the loose fragments from this spot show disseminated grains of chalcopyrite, altering to azurite.

Only a very few fossils were seen, the following being representative: seaweed, crinoid columnals, the brachiopod *Rafinesquina mucronata Foerste* and the pelecypod *Byssonychia (?)* sp.

SILURIAN SYSTEM

The greater part of the inface slope of the Allegheny cuesta in this area which is largely south of the Mohawk river, is underlain by the following Silurian formations, from north to south: Oneida conglomerate, Clinton sandstones and shales, Lockport dolomite and shales, Salina beds and the Manlius group. Much has been written about these formations because of their interesting and varied history, their paleontology, stratigraphy and economic geology, particularly as regards the Clinton.

Clinton Beds

This group (Vanuxem 1842) took its name from the village of Clinton in Oneida county, but when Vanuxem (1837, 1838, 1839) originally studied it he referred to it as the Protean group and defined it as follows:

The Clinton consists of many different kinds of rocks or masses; from which circumstance the name of Protean group was given to it the first year that it was examined. It then embraced the Niagara or Lockport limestone and shale, which formed the upper part; they were separated on account of their importance in the west, and their disappearance in Herkimer county. The name of Clinton was given to the lower part, characteristic masses being found around the village of Clinton in Oneida county, and as a tribute to one who spared no effort to extend a knowledge of science, and to add to its acquisitions. The group consists of green and black-blue shale, greenish and gray sandstone, red sandstone, often laminated, calcareous sandstone, encrinal sandstone and red fossiliferous iron ore beds.

Since that early description was published, there has been much investigation and study of these beds. Students such as James Hall, 1843 and 1852; Amadeus W. Grabau, C. H. Smyth jr, C. A. Hartnagel, D. H. Newland, G. H. Chadwick, E. O. Ulrich and R. S. Bassler, among others, have contributed largely to our knowledge of the area, yet much remains to be done to make possible a more satisfactory interpretation.

The Clinton beds extend from the town of Cherry Valley in Otsego county to the Niagara river and thence for some distance into the province of Ontario. In New York State they are apparently confined to a single belt about 225 miles in length though only a tenth of this is seen in the Oriskany quadrangle. Elsewhere in the United States the Clinton occurs in a number of states including Ohio, Wisconsin and Alabama. Though of the same general age in these occurrences the Clinton does not correspond exactly in other respects and hence it is believed that deposition was made in separate basins.

The distribution of the Clinton in the Oriskany area can be seen on map. Its first appearance along the east boundary of the area is seen northeast of Washington Mills. It then extends southwest to Willowvale from which point the formation continues under the Sauquoit valley to the southern limits of the area. The belt then swings north and northwest along the east slope of the Paris and Crow Hill mass, and then west along the north slope of the cuesta as far as the Oriskany valley. On both the east and west sides of this valley the Clinton is exposed especially along important tributaries such as Dawes creek, Stebbins creek, Rogers creek and Jupiter Hollow creek, the first two creeks occurring on the eastern slope and the latter two on the western slope of the valley. Most of the early mining operations have been carried on near and between these tributaries as can be seen on map 1. The belt extends as far south as a point midway between Farmers Mills and Clinton then north to Kirkland where the formation is a mile wide. As the formation swings west and northwest from Kirkland it widens out between Lairdsville and Westmoreland as a belt of more than five miles as far as the western limits of the sheet. Also a circular area between Bartlett, Dix, and the Oriskany battle monument, although showing no outcrops, is assumed to be underlain by Clinton rocks since the interval between the 600 and 700-foot contours is underlain by Clinton rocks in the Oriskany valley and in the region about Westmoreland, the Hecla Works and Lairdsville.

The members of the Clinton group are as follows:

Upper Clinton	Herkimer (Rochester)	Sandstone, arenaceous shales and sandy dolomites Red flux, sandy dolomites and shales
	Willowvale	Suboölitic hematite (lean ore zone), dolomitic sandstones and shales Green shales and sandy dolomites Oölitic hematite
Middle Clinton	Sauquoit	Green shales and sandy dolomites Gray and red sandstones, shales Shale and quartz conglomerates
Lower Clinton	Oneida	Conglomerate

Basal Clinton: Oneida conglomerate. This is one of the best-known and most easily recognized rock units in New York State geology. Occurring directly above the Frankfort formation in central New York and consisting of white quartz pebbles and cross-bedded sandstones in large part, with its surface strongly oxidized in places and frequently marked and pitted by the leaching or weathering of shale fragments, its identification is very simple.

In 1824, Emmons originally described this formation under the name "millstone grit," and gave it a stratigraphic position above the Lorraine and below the Medina. T. A. Conrad (1837), Vanuxem (1838 and 1842), Hall (1838), Grabau (1906) and Hartnagel (1907) have all studied the nature and position of this formation, and their conclusions as to its position were quite different. Hall placed the Oneida below the Medina, Vanuxem above the Medina, Grabau, in one paper at least, as a basal conglomerate which in age ranged from basal Medina to basal Clinton. Hartnagel placed the Oneida near or at the top of the Medina. According to Goldring (1931, p. 324) the Oneida conglomerate "rests upon the Upper Medinan beds in Oswego county; disappears westward in Wayne county; and in Otsego county the eastern extension in the Mohawk valley rests upon the Frankfort shales. The excellent exposures in Oneida county in the vicinity of the village of Verona gave it the name." It is now generally accepted that the Oneida belongs in the Lower Clinton.

Some of the best exposures of the Oneida conglomerate are found in the townships of New Hartford, Kirkland and Westmoreland. Two old road metal quarries in New Hartford, one a mile northeast of Washington Mills and the other a mile southeast of Washington Mills, or a mile and a half nearly due south of the first quarry, illustrate the rock types very well. In both occurrences there are eight to ten-foot sections of cross-bedded sandstones and conglomerates with strata dipping five to ten degrees to the southwest. *Arthrophycus alleghaniensis* was observed at the southern quarry.

The fine cross-bedding, with its uniform nature, the narrow width of the foreset beds and nearly horizontal attitude of the beds overlying the foreset would suggest to the writer an origin resulting from the outward building of the bottom in an inland sea along the shore.

Under the microscope the Oneida conglomerate and sandstone are seen to be essentially quartz rocks in which the grains and pebbles are semiangular to rounded in shape, and present either a conglomeratic or mosaic texture. The mosaic texture indicates that in some of the rock secondary silica has been deposited upon the original grains as shown by the angular boundary lines of the pebbles or grains in contrast to the inner outline of the original pebble or grain. As a consequence of the deposition of secondary silica much of the sandstone is quartzitic.

In some specimens of the less quartzitic types where the grains are semirounded we find dolomite replacing the original cement of silica. Pyrite, magnetite and kaolin are the main accessories. The occurrence of sulphureted waters derived from the Oneida is undoubtedly due to the alteration of the pyrite.

Clinton outcrop. There are two well-known exposures of the Oneida near Clinton, one on Utica street, one and one-fourth miles northeast of Clinton, and the other two miles northeast of that village, and south of the Moreland farm, in a place known locally as "Rock City," in allusion to the great, citylike blocks of jointed strata found there. The Utica Street occurrence has long been known and studied by many geologists. It is just east of the road, near the old trolley stop 12. Because of its rusty appearance and 20-degree southwesterly dip, it is readily recognized. In the more coarsely conglomeratic parts of the exposure many pebbles are more than one-half an inch in diameter, and semirounded. Cylindrical holes, one-half to one inch in diameter and an inch more or less in depth, can be accounted for in part through the leaching out of shale fragments or pebbles. This outcrop has conspicuous S. 30° E. to S. 35° E. glacial striations and is polished, characteristics which will be considered later.

Such a structure involving the steep 20-degree southwesterly dip, the nearly horizontal attitude of the Oneida conglomerate at "Rock City" and the nearly flat-lying beds of the Middle Clinton in Stebbins creek a short distance to the south could be explained by monoclinal folding. The interpretation of this structure and its age will be discussed later.

Moreland Farm "Rock City" outcrop. This exposure is located about one-half a mile south of the Moreland farm on Route 5. A striking, flat-lying ledge of white quartz conglomerate and sandstone of the Oneida formation is seen here. Due to sapping of the underlying Frankfort and the consequent slumping of the Oneida, blocks of this formation are wedged apart along joint planes trending north-south, N. 70° E., N. 60° E., N. 15° E. and N. 75°W., so that in some cases they are three or four feet apart with the separating trenches five to seven feet deep and occupied by growing trees. These trees are doubtless producing some mechanical weathering effects (figure 8). Whether or not the continental glacier aided in the wedging apart of these blocks or whether it was done mainly through the sapping of the underlying Frankfort and the wedgework of ice in the overlying Oneida is not known, but it is a noteworthy feature wherever these two formations are in contact in central New York. The writer believes that the sapping action is the main agent responsible for the slumping. The sapping of this formation has been responsible in part for the migration of the lower part of the Allegheny cuesta from the north side of the Mohawk southward.

Lairdsville outcrop. Between Lairdsville and Tindall Corners at the mouth of Lairdsville gorge is an eight to ten-foot section of cross-bedded, rusty quartz-sandstone and conglomerate with strata three to six inches thick which are strongly rippled and cross-bedded in places and dipping five to ten degrees to the southwest. The upper beds show a course vesicular structure due to the leaching out of shale fragments or clay pebbles. The upper surface of the Oneida nearest the green shale member of the Sauquoit is very irregular either as the result of differential erosion or a rippled surface. Until this section has been studied for ostracods, it is difficult at this writing to include it definitely in the Oneida conglomerate formation. The upper part of the section may be Sauquoit as there is considerable shale admixed with the sandy and conglomeratic beds near the contact with the overlying green shale member of the Sauquoit.

Mallory Creek outcrop. The stratigraphic position of the Oneida is best shown on Mallory creek, one mile southeast of Washington Mills in the Sauquoit valley (figure 7). Here is a ten-foot section of cross-bedded sandstones and conglomerates overlying the Frankfort shales disconformably. Within the lower 20 inches, the Oneida is dominantly a dark gray sandy shale with a one to seven-inch bed of rusty conglomerate (pyrite altering to limonite) at the base and intercalated with thinner beds of conglomerate above. This pyrite zone is probably the source of the sulphureted waters observed elsewhere on the quadrangle. This rusty zone appears to be somewhat nodular and concretionary in character. The undulatory contact, suggested by the variable thickness of the pyrite zone, may be explained as due to the deposition of sands and gravels upon a pararippled Frankfort surface. There appears to be a disconformable surface between the lower Silurian and upper Ordovician by overlap, with the Pulaski and Oswego strata missing, thus clearly indicating a physical break between the Lorraine and the Medina, of Ordovician and Silurian age respectively.

As the next 55 feet above this exposure are covered there is no way by which we can ascertain the limits of the upper member of the Oneida formation at this locality.

Thickness of the Oneida. As can be observed from the descriptions of the Oneida exposures above, it is not possible to even estimate the true thickness of the Oneida in this area since at no locality was there a complete section in contact with both the overlying Sauquoit and the underlying Frankfort. So far ten feet is the greatest thickness of Oneida exposed on this quadrangle. Even if a complete section were exposed, it would be difficult to delimit the formation for the present except on a purely lithological basis, using as the chief criterion the predominance of quartz-pebble conglomerate and cross-bedded sandstones. From a recent examination of the Moyer creek outcrop of the Oneida where there is exposed at least 30 feet of Oneida conglomerate above the Frankfort, a thickness also found less than 20 miles to the east on the Utica sheet, for the present at least we have too few facts to aid in the estimation of the true thickness of the Oneida. The writer believes, however, that the thickness of the Oneida is over ten feet and probably less than 30 feet. Conditions of sedimentation, under which shales, such as the Frankfort, are succeeded by coarse deposits, must have been brought about by the more rapid erosion resulting from greater elevation of the land not far to the north and east. In any case the very coarseness of the Oneida and its increasing thinness to the west would indicate the proximity of the source somewhere to the north and the east.

Middle Clinton: Sauquoit beds. The Middle Clinton in the Oriskany area is represented by all the rocks between the Oneida

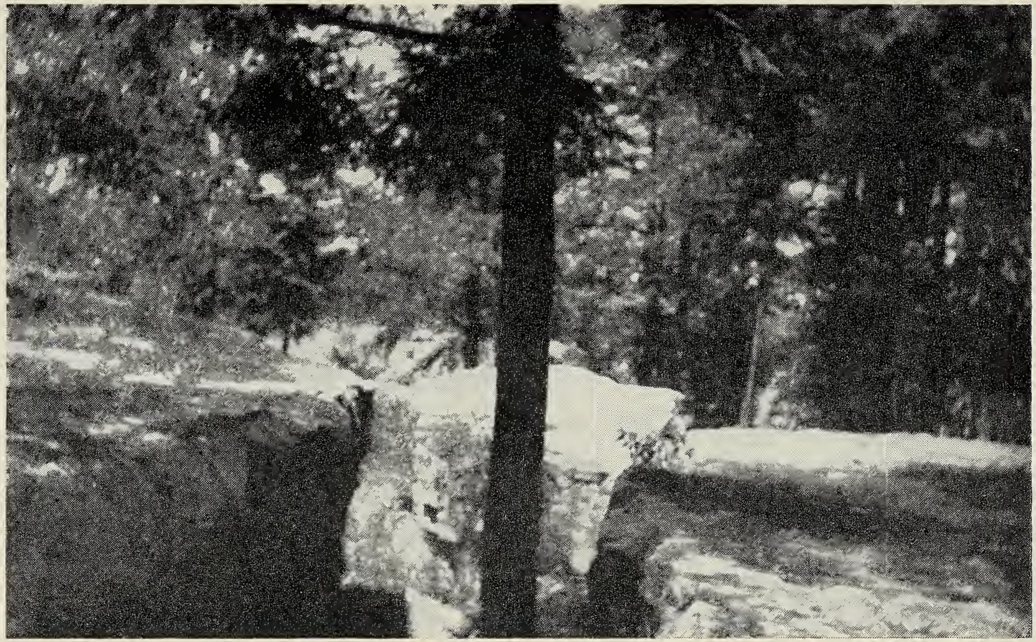


Figure 8 Oneida conglomerate at "Rock City" showing joint planes widened or spread apart through sapping action of underlying Frankfort. (Photograph by N. C. Dale)

conglomerate and the oölitic hematite, otherwise known as the Sauquoit beds, a term, applied by Chadwick (1918, p. 341) to these rocks in the Sauquoit valley. In the lower part of the Sauquoit, the rocks are essentially gray and red sandstones, gray fissile shales, sandy shales, shale and quartz conglomerates. The sandstones are cross-bedded and the shale conglomerates are frequently leached of their pebbles of shale or clay giving rise to a coarse vesicular structure. In the upper Sauquoit the rocks are essentially green and gray shales with dolomitic lentils with occasional oölitic and concretionary phosphate and chamosite. At no one locality in this area do we find an uninterrupted sequence of both parts of the Sauquoit; either portions of both are exposed or a portion of only one. Several of these sections are worthy of presentation, such as that of Mallory creek, Willowvale and Stebbins creeks.

Mallory Creek section. This section, only a very small part of which is exposed above the Oneida conglomerate, is as follows:

	Covered	
Upper Clinton: Willowvale	Suboölitic red flux Green shales and sandy dolomites	27 feet
Middle Clinton: Sauquoit	Oölitic hematite Covered Olive-green shales with sandy dolomite lentils Sandy shales, shale conglomerates, ferruginous sandstones Covered Olive-green shales with sandy dolomite lentils Covered Cross-bedded gray and red sandstones, shale conglomerates....	281 feet
	Covered	55 feet
Lower Clinton: Oneida	Quartz conglomerate and cross-bedded sandstones	10 feet
	Disconformity	
Frankfort	Shales	

Above the covered area succeeding the Oneida there are about 30 feet of sandstones and shales. This section, measured by W. L. Grossman in connection with the work on the Utica quadrangle, occurs also on the Oriskany quadrangle, though only 186 feet of the Sauquoit is found in that area.

The coarser members of the section consisting of sandstones and conglomerates are of undetermined thickness because so much of the section is concealed by valley filling and glacial drift. In the lower exposure 55 feet above the Oneida conglomerate the formation consists essentially of thin, cross-bedded, shaly conglomeratic beds, overlain by a foot of ferruginous sandstone. The light green shale conglomerate shows an unusual percentage of shale pebbles with quartz grains and, to a lesser extent, quartz pebbles associated with them. Most of the formation, however, is made up of discoid-shaped pebbles whose longer axes are approximately and generally parallel with the bedding plane. Whether these pebbles were originally fragments of the underlying Frankfort and subsequently reworked on the Oneida beaches, or whether they were incorporated, flattened, claylike masses is difficult to decide but their shape as well as their composition would influence the writer in assigning a Frankfort source for most of them.

Other than a few tracks of invertebrates, no fossils have been found at this locality, but it is desirable that an intensive search for ostracods should be made.

That these beds are dominantly clastic and shallow water in origin is indicated by the conglomerates and sandstones both of which show cross-bedding in which respect the shore conditions of deposition were not unlike those of the Onedia conglomerate.

Stebbins Creek section. The location of this section is along the bottom and slopes of the main tributary of Mud creek, formerly Stebbins creek, which is just east of the Borst mine. The section starts within 500 feet of where the creek flows under Utica street and the outcrop of Oneida conglomerate described in earlier pages. Only part of the Upper Clinton and the green shale member of the Sauquoit or Middle Clinton are represented in this section:

Upper Clinton: Willowvale	Suboölitic (lean ore) and red flux zone with heavy sandy dolomite beds	8 feet
	Green shale with sandy dolomite beds (very fossiliferous)	28½ feet
	Oölitic hematite (ore)	2 feet
Middle Clinton: Sauquoit	Green and gray shales with sandy dolomites, rare oölitic and concretionary phosphate and chamosite	160 feet

Rogers Glen-Willowvale section. This section is exposed along the bed and slopes of an east-flowing tributary of Sauquoit creek in the town of Willowvale. The creek flows through what was formerly known as Rogers glen. Three artifically created ponds along the course of the creek supply water for the bleacheries in the village of Willowvale below.

The section, measured by a hand level, gives the following thicknesses for the main subdivisions of the Clinton:

			Feet	*Inches*
		Covered	27	8
Upper Clinton	Herkimer	Shale and sandy dolomite	21	6
		Heavy sandy dolomite and shale	16	0
	Willowvale	Oölitic hematite	2	0
		Shale and sandy dolomite	80	11
Middle Clinton: Sauquoit		Shale and sandy dolomites Casts of channel marks		
		Shale and sandy dolomites and quartz conglomerate		
		Green-gray and sandy shale with black sandstone dolomitic lentils		
		Shale with interformational conglomerate		
		Calcareous sandstone and black dolomitic sandstone		
		Green shale with worm tracks		
		Green shale with sandy dolomites and black sandy concretionary bodies in scour and fill structure		
		Green shale and ferruginous sandstone and dolomite	51	10
		Covered	10	8
		Main Street Willowvale Creek conduit	0	0

In this section, no Oneida conglomerate or basal Clinton is in evidence, though, in all probability, it underlies the first ten feet of the section above the Willowvale Creek conduit in part. The Sauquoit is better represented in this section and its composition appears to be more varied than in any part of the quadrangle. It is predominantly a clastic and shallow-water deposit. The unusual feature of these beds is the rather frequent occurence of black dolomitic-sandstone lentils which, according to microscopic analysis, consist of angular grains of smoky quartz, dolomite and calcium phosphate or collophanite. The total thickness of the Sauquoit is 132 feet and 9 inches.

The Willowvale is decidedly thinner than in any other section as it is represented by only two feet of oölitic hematite. Because of the large amount of carbonate (calcite) in this oölite, it is barely possible that it may be a suboölitic member of the Willowvale rather than the main oölitic member.

No evidence of the red flux member of the Herkimer was observed in this section and only a part of the Upper Herkimer shale and sandy dolomite was seen.

As can be seen from the accompanying Stebbins Creek section which is located on the east side of the Oriskany valley, the Clinton proper starts at the bottom with an olive-green shale, referred to as the lower Clinton shale by Vanuxem (1842, p. 89), and continues for a thickness of nearly 125 feet, containing intercalated lentils of sandy dolomite, varying in thickness from 25 to 50 centimeters. These lentils are usually pyritiferous and sometimes phosphatic, the latter substance present in the form of small, subspherical to discoidal-shaped concretions, from one to 12 millimeters in length, and three to five millimeters in diameter. For the description and discussion of the origins of these concretions, the reader is referred to later pages. Although these shales are for the most part olive-green in color toward the bottom of the formation, they tend to become grayer toward the oölitic hematite zone, and undoubtedly correspond to Chadwick's and Gillette's Sauquoit beds. These shales are essentially horizontal up to a point where the influence of the monocline is shown by conspicuous plicated shales in the bed of the brook, within 500 or 600 feet of Utica street. The plicated shales are followed shortly by a conspicuously inclined dip of the dolomitic lentils in the bed of the stream, as well as, in all probability, the entire overlying Clinton. There is a marked dip of 15° to the southwest. Whether any of this green shale at the bottom belongs to the Maplewood of Chadwick is doubtful, because *Coelospira hemispherica* is found sparingly from top to bottom of the series. This fossil is more characteristic of the Sodus, according to Hartnagel; furthermore, the Sodus is one of the most persistent of the rock types in the Clinton. According to the latest work by Gillette, this shale belongs to his *Mastigobolbina lata* zone, and is classified by him as Chadwick's Sauquoit.

Occurrence of the phosphate zone. It has been found that the phosphate zone is not restricted to the green shale member of the Sauquoit, as it also occurs in the underlying clastic beds, as in Willowvale and in the Hecla section, just below the hematite. These phosphatic bodies are best seen in several of the sandy dolomitic lentils, with their longer axes more or less aligned, and measuring about one to 11 millimeters in diameter. These subspherical, discoidal-shaped bodies are dull black and lustrous, weathering to a bluish white color, and are scattered through the dolomite, generally to the bottom of the bed. Occasionally, pebbles of quartz or shale, as well as pebbles of clastic quartz, are set in a groundmass of the phosphatic substance, as though this substance possibly was deposited in the form of a colloid and assumed the rounded form through movement along the ocean bottom. In the Hecla occurrence the phosphate appears as brown bladed or spindle-shaped bodies, resembling closely fragments of organic matter; but they are char-

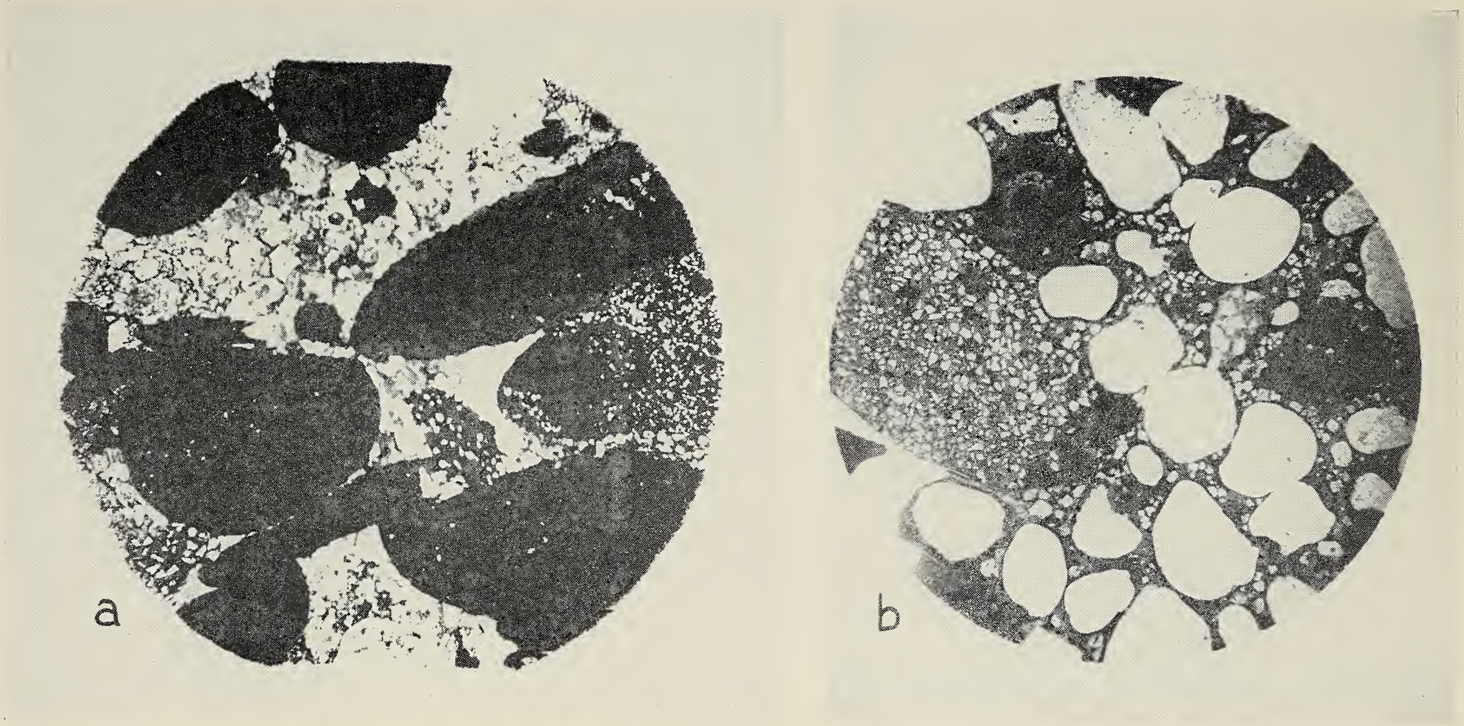


Figure 9 Microphotographs. *a* Concretionary phospate in carbonate (dolomite) groundmass, x 80. Stebbins creek, Clinton, N. Y.; *b* oölitic, concretionary and rolled phosphate types, x 80. Stebbins creek, Clinton, N. Y.

acteristically isotropic. They also appear as oölites set in a greenish brown amorphous mineral, having a brownish color and aggregate polarization, with characteristics of chamosite and clinochlore (see figures 9*a* and 9*b*).

Crinoid segments and fragments of brachiopods and trilobites appear to have the same phosphatic composition. Some of the oölites have a nucleus of phosphate, an inner envelop of quartz or calcite and an outer envelop of phosphate. Still another has a nucleus of calcite. Several of the rounded phosphate masses suggest aggregates of smaller, rounded masses of phosphate. A longitudinal section of a crinoid head was found to be phosphatic and calcareous in composition.

Most of the phosphate bodies referred to above appear to be concentrated either at the top or bottom of one of the lentils, but they may be distributed more or less uniformly throughout in other sections.

A certain amount of phosphorus is found in the Willowvale shale between the oölitic ore and the red flux horizon where crinoid columnals or inarticulate brachiopods show their phosphatic nature by their dark color and bluish white weathering. Chester found .53 per cent to .97 per cent of P_2O_5 in the oölitic hematite, and Smyth reports 1.42 per cent for the chamosite. It has also been noted in the coarser clastic members of the Sauquoit, just above the Oneida.

The phosphate described above is found to occur in the following forms:

a Concretionary bodies with and without concentric structure (figure 9a)

b Oölitic phosphate (figure 9b)

c Rolled pebbles of phosphatized sandstone (figure 9b)

d Phosphatized invertebrate material

In group *a* the concretionary bodies of phosphate are found to occur with and without concentric structure. For the pure concentric types described above the same observations have been made for both oölitic hematite and chamosite. In the case of the phosphatic types we find that they possess either a nucleus of quartz or of phosphatic quartz sandstone, with an envelop of phosphate and calcite. An unusual oölite from the oölitic hematite zone was found to have a nucleus of quartz, with scales of blood-red hematite, or goethite, arranged irregularly, and enveloped by a band of hematite one-half millimeter thick, which in turn is followed by an envelop of concentrically-banded phosphate one-tenth millimeter thick. Other brown, phosphate-banded envelops contain only hematite, quartz and calcite aggregates as nuclei. In another example a nucleus of phosphatic substance was enveloped by a band of quartz or calcite, outside of which was an envelop of phosphate. Other concretionarylike types were found to exist without nuclei. So far as this type is concerned, it would appear that both rolling and concretionary action involving colloidal solutions have played a part in their shaping.

In group *b,* the oölitic type, the chemical conditions on the sea bottom were nicely balanced between solutions and colloids. Type *a,* with and without concentric structure, might have very much in common with the oölites; in fact, this type can hardly be distinguished from them, because it would be difficult to determine whether the oölites had rolled after their formation on the sea bottom.

In group *c* we find segments of crinoids and fragments of brachiopods and trilobites composed of phosphate of lime which has replaced the original calcium carbonate. This replacement undoubtedly took place while the sediments were in a soft condition, as evidenced by the chemical nature of the concretionary phosphate described above.

The occurrence of concretionary phosphate, rolled phosphatic pebbles and invertebrate fragments composed of phosphate of lime leads the author to conclude that these phosphatic substances were largely primary and originated mostly through precipitation on the sea bottom where there were accumulations of clastic and organic sediments. This most certainly applies to the phosphate-cemented pebbles of sandstone, which have taken on their spherical shape partly from rolling on the sea bottom, and also to the nodular and oölitic types, and the invertebrate fragments as well. With the abundance of decaying organic matter present, precipitation of the phosphate is favored. The source of the phosphate is to be found in the hard parts of organisms, or other organic matter, from which it is eventually brought into solution, or into the state of a colloid, through decomposition. Some object, such as a grain or pebble of quartz or carbonate, serves as a nucleus for the precipitating calcium phosphate. The phosphatic substances may have been reworked by ocean currents after reaching a more or less consolidated state, which process may account for the rounded or elliptical shapes of some of the phosphatic bodies. Found as they are, in clastic rock types, we may expect the above process to be operative in relatively shallow water (Murray and Renard, 1891, p. 391-400).

Little more can be said regarding the origin of phosphatic oölites, other than that they signify the presence of phosphatically rich solutions or colloids near the sea bottom. The oölites were formed directly from these through chemical precipitation with or without the aid of physical or mechanical accretion. One wonders, also, if bacteria may not have played an important role in their origin, as they have been known to do in the case of iron and manganese. Credner (1895, p. 26) experimented with calcium phosphate, and found that "calcium phosphate of fish remains after its extraction with water containing carbon dioxide, will, in the presence of ammonium carbonate, react to form calcium carbonate and ammonium phosphate.

This last substance, with additions of more calcium carbonate, changes again to calcium phosphate and ammonium carbonate. These conditions, which have been reproduced in the laboratory, are believed to be present on the sea bottom, where a cycle of chemical reactions takes place among such solutions by which fragments of the hard parts of invertebrates become phosphatized. Tricalcium phosphate (in the form of collophanite, or of carbophosphates, such as dahlite) may be precipitated chemically in colloidal or amorphous form, or may, perhaps, be extracted from solution by bacteria as above suggested. Small objects or fragments of various sizes and kinds may serve as nuclei, or oölites, or the oölites may form without any core of foreign material. The conditions of chemical equilibrium at the sea bottom are unknown, but the presence of beds of phosphatic limestone in association with beds of phosphate appears to indicate that changes in concentration of the various constituents of the solution on the sea bottom were perhaps controlling factors in determining which substance should be precipitated (Mansfield, 1931, p. 369-70).

Mansfield, in considering the oölites and pisolites of phosphates of the Rocky Mountain region (1918, p. 591), claims that they were deposited as aragonite which was later phosphatized by impregnation with ammonium phosphate produced from bacterial decay of marine organisms. He considers this to have been done in shoal waters, under conditions of warm and moderate temperature. Pardee (1917, p. 226-27) claims "that conditions especially favorable to the solution and retention of calcium carbonate by the sea water, but not hindering the ordinary precipitation of phosphate, existed for a considerable time," and thereby classifies them as primary in origin. As many of these phosphate bodies are not oölitic in structure, as observed by Twenhofel (1932, p. 760-61) and the writer, it is quite likely that they may not be related in any way to oölites. "These particles are probably best interpreted as excremental or coprolitic in origin, many of which seem to have functioned as nuclei, around which were precipitated concentric laminae" (Twenhofel, 1932, p. 761).

Occurrence of chamosite. Another unusual concretionary mineral found both above and below the oölitic hematite at Clinton and at

Lairdsville is known as chamosite, a hydrous silicate of iron, aluminum and magnesium. In the Clinton area at the old Borst mine it is found just five inches above the oölitic zone and associated with the pyrite seam, in what is known as the Willowvale shale. It has also been recognized in the same zone at Rogers glen, and at Lairdsville. The late Dr C. H. Smyth (1917, p. 175-78) describes the chamosite oölite as "a dark gray, nearly black, oölite, which is well shown at the upper end of a ravine on the Burns farm, about one-half mile east of the Borst mine, at Clinton, N. Y., at a point where a small stream flows through some abandoned surface workings." The section below the abandoned stripping, just east of the Borst mine, consisting of gray shales and dolomitic sandstone lentils, measures some 160 feet in thickness below the hematite. Just 18 inches below the top shelf of this stripping, or the bottom of the oölite zone, the chamosite appears in a thin stratum of one-half to three-fourths of an inch, consisting of gray oölites set in a ground mass of crystalline carbonate. Disseminated aggregates and grains of pyrite of less than 1 per cent in volume are found concentrated at the lower and upper parts of the oölite zone, and to a less extent throughout the zone. Finely divided pigmented hematite is also found scattered throughout the zone. Some quartz grains measuring 8 x 14 mm are found enveloped in part by chamosite, and in part by chamosite and carbonate. One rare composite oölite of quartz and chamosite is found enveloped by pyrite. Quartz is also sometimes found in fragmentary form detached from any chamosite. Some chamosite oölites have phosphatic envelops, while others have quartz nuclei with a concentric band of phosphate between the quartz and chamosite. One quartz nucleus shows an envelop of chamosite, which in turn is enveloped by phosphate, with an outer concentric band of chamosite (see figure 10). The oölitic chamosite is not alone restricted to the shale below the oölitic hematite, as just described, but is found in the very thin seam of the Willowvale shale, at the old Borst mine, at the College Hill ravine and in Lairdsville gorge. In the Lairdsville section, and six inches above the main oölitic zone, is a one-inch band of oölitic chamosite. Under the microscope, the nuclei appear to be just as varied as in the section just described. Here is found most of the chamosite associated with the carbonate material, with a few straggling oölites projecting into the shaly parts. Again it would appear that the oölites must have formed while the sediments were still unconsolidated. It was during this stage that the various minerals represented by the chamosite, the carbonates and the hematites were precipitated as colloids or as amorphous hematite or as crystalline substances, on a sea bottom consisting of slowly moving fragments

Figure 10 Microphotograph of oölitic chamosite in dolomitic groundmass, x 80. Nuclei of quartz grains (light); groundmass dolomite (gray), Stebbins creek, Clinton, N. Y.

of clastic materials, such as quartz. Some of the oölites of chamosite have as their nuclei aggregates of calcite, quartz and chlorite, the calcite being impregnated with hematite. Some of the concentric chamosite bands envelop spherical aggregates of sandstone as nuclei. Some of the nuclei have aggregates of chlorite, while others contain shale pebbles. Still others consist of hematitic carbonate, quartz and chlorite. One chamosite oölite has a nucleus of calcite, with a fringe of hematite or goethite, succeeded by chlorite on the outside. One composite nucleus consisted of hematitic carbonate, quartz and chlorite. Some of the chamosite envelops are very thin and concentric laminae of hematite, carbonate and quartz. Sometimes nuclei are entirely missing from oölites, or nuclei are found coalescing with nuclei of other oölites, with a single thin outer envelop of hematite. Carbonate rhombs are found indenting the chamosite or hematite included with the carbonate. Certainly some of the carbonate antedates the chamosite in origin, while other carbonate material is of later or contemporaneous origin.

Smyth reports (1917, p. 176) that ". . . a notable feature of the occurrence, indicating the conditions under which deposition took place, is the presence of the gray spherule in the filling of mud-cracks in the underlying shale." Although the author failed to find this particular occurrence, it was observed that the oölites were found in the underlying and overlying shales, but, of course, less abundantly than in the carbonate areas. It would appear therefore that the oölites were formed as such when the oölitic layer was deposited upon the underlying muds under very shallow water conditions. From the above description it would also appear that these oölites are, for the most part, of chemical and mechanical origin, as shown by their varied concentric structure and nuclei. The concentric structure of the envelops, consisting largely of chamosite, quartz, carbonates, phosphate and hematite, is obviously largely of chemical origin.

"It seems clear that, while the deposition of the shells began during the free movement of the nuclei, the process was completed only after the latter had come to rest. Moreover, the frequent bent and twisted shape of the shells strongly suggest a somewhat soft, jelly-like condition during their formation" *(ref. cit.)*. Sometimes the outer rim shows a minutely fractured appearance, as though the outer envelop underwent deformation after consolidation. From the above description of the occurrence of the chamosite and the conditions of sedimentation, it is seen to be very similar to the deposit described by A. O. Hayes in connection with the Wabana iron ores of Newfoundland (1915, p. 26-27, 42), except that in the Clinton ores the chamosite is found above and below the main hematite bed and not in the ore itself. Just as there is a more widely distributed occurrence of the chamosite than Smyth reports, so also, it is found that the oölites have a far more varied composition.

The chemical composition of the gray oölite, as analyzed by Professor Morley for Smyth's paper, is as follows:

	Soluble	*Insoluble*	*Soluble*	*Insoluble*
SiO_2	9.20	24.21	10.45	28.81
Al_2O_3	8.31	0.39	10.03	0.62
Fe_2O_3	1.70	4.11	0.83	1.40
FeO	16.00	0.00	18.41	0.00
MgO	6.18	0.06	5.00	0.07
CaO	9.25	0.12	7.65	0.00
Na_2O	0.06	0.03	0.23	0.13
H_2O-	4.41	...	3.45	...
H_2O+	0.07	0.09	0.14	0.09
CO_2	0.10	...	0.12	...
TiO_2	0.05	0.15	0.07	0.17
P_2O_5	1.03	0.00	1.42	0.00
S	0.00	2.58	...	1.05
MnO	0.20	0.00	0.30	0.00
BaO	0.00	...	0.07	...
SrO	0.01	...	0.09	...
Less	0.64	...	...	...
	100.43		99.67	
SiO_2 sol. in HCl...	0.28	...	0.38	...

The soluble silica in the above analyses was obtained by dissolving in sodium hydroxide the gelatinous silica resulting from digestion in hydrochloric acid. The large amount of insoluble material was explained as due to the presence of the large amount of detrital quartz and pyrite found *in situ*.

By recalculation of the above percentages, the phosphorus being treated as $Ca_3(PO_4)_2$, the calcium and magnesium as carbonates and the ferric oxide as disseminated hematite, the apparent amount of calcium phosphate, phosphite, dolomite and hematite is found. The SiO_2, Al_2O_3, FeO, MgO, recalculated to 100 per cent, give the results as shown in the analyses 1*a* and 2*a* below:

	1*a* (38.84%)	1*b*	2*a* (44.41%)	2*b*
SiO_2	23.68	28.49	23.53	25.09
Al_2O_3	21.39	23.13	22.58	24.08
Fe_2O_3	...	...	...	...
FeO	41.21	19.09	41.46	29.11
MgO	2.37	17.79	4.66	13.44
CaO	...	...	...	...
Na_2O	...	...	...	...
K_2O	...	...	...	...
H_2O+	11.35	12.70	7.77	8.28
H_2O-	...	...	...	...
MnO	...	...	...	...
	100.00		100.00	

Smyth compared these results with those obtained for chamosite of Schmeiderfeld (Zalinski, 1904, p. 77), chamosite of Wabana, Newfoundland (Hayes, 1915, p. 59), chamosite of Windgallen (C. Schmidt, quoted Zalinski, 1904, p. 78), thuringite of Gebersreuth (Zalinski, 1904, p. 78), greenalite of Mesabi (Analysis by Steiger in Leith, 1903, p. 246), glauconite of Padi, Russia (Glinka, 1889, p. 390), and glaucomite of Station 164B, Challenger Expedition v. 3 (Murray and Renard, 1891, p. 387) ; and he concluded that ". . . the mineral composing the shells is evidently a hydrated ferrous aluminum silicate, and is a member of the rather indefinite group of chlorites, such as chronstedite, thuringite, delessite, and its closest affinity seems to be with the chamosite variety of thuringite—that is, the variety rich in ferrous iron, and poor in ferric iron." Smyth has suggested that samples carefully prepared and separated by heavy solution might yield a precise silicate formula, although this would be an exceedingly arduous task. He has also assumed in the above analyses that all the carbon dioxide is combined with the calcium and magnesium, but it might very well be combined with the iron, thus reducing the amount of iron in the carbonate and increasing it in the silicate. "The replacement of FeO by an equivalent amount of MgO will not, of course, change the essential composition of the mineral. The true composition is doubtless somewhere between the extremes represented, respectively, in 1*a* and 1*b* and 2*a* and 2*b*. Thus there appears to be sufficient evidence for classing the ferrous silicate of the grey oölite as chamosite, at least if the name be used in the rather general sense given it by Lacroix (1893-95, p. 397) and many others, even if not in the more exact sense assigned to it by Zalinski (1904, p. 40-84)."

The primary nature of these oölites, and of the other oölites of ferrous and ferric iron described further on, as well as the relation of these to the carbonate, will be taken up later.

Upper Clinton beds. In this area all rock units from the bottom of the oölitic hematite to the base of the Lockport are included in the Upper Clinton. Lithologically these units are definite and distinct and are known as the oölitic hematite, green shale with pyrite-bearing sandy dolomite lentils, suboölitic hematite-bearing sandy dolomite beds, red flux and the main pyrite-bearing sandy shales and dolomites:

Upper Clinton	Herkimer sandstone Willowvale: oölitic hematite, green shale, suboölitic hematite, sandy dolomites and red flux.

Willowvale Formation

The section between and including the oölitic hematite and the red flux has been variously designated by students of the Clinton, such as Chadwick, Ulrich, Bassler, Hartnagel, Sanford and Gillette. Chadwick refers to it as the Van Hornesville sandstone; Ulrich and Bassler, as the Keefer-Irondequoit, Brewerton; Hartnagel and Sanford, as the Williamson; while Gillette from his most recent study of the Clinton, based upon the study of ostracods, rejects all the above designations and calls it the Willowvale, "as the eastern equivalent of the combined Irondequoit limestone and Williamson shale in the Rochester region. This formation is the only eastern representative of the *Mastigobolbina typus*. It bears the same ostracods as the Irondequoit and the Williamson" (figure 11).

As Gillette has made the most thorough paleontological study of certain sections in the Oriskany sheet, and is familiar with the ostracod fauna to the west and, as the Willowvale section is the most complete in this area, extending from the Oneida to the Vernon, the writer is inclined to accept his designation of the Willowvale. Chadwick's term, Van Hornesville sandstone, "a red coarse hematite-quartz mixture at Van Hornesville" (Chadwick, 1918, p. 351), on the basis of lithology, could hardly be applied to the Willowvale. Hence it is rejected by the writer as the proper term for the Clinton locality. Several sections of the Willowvale are noted in this Clinton area, notably the Stebbins Creek section, which we have already discussed, the Borst mine and other old Clinton mines, and the Willowvale section. The Borst mine section is based upon observations made on the outside several years ago, and shows the following thicknesses:

Borst Mine—Outside Section

	Feet	Inches
Glacial till .... } Shale .... }	11	..
Shale with pyrite and chamosite	..	3.
Oölitic hematite	..	5.
Parting (green shale)	..	.5
Oölitic hematite	..	15.6

From the purely lithological viewpoint, the Willowvale formation of the Clinton has three conspicuous rock units, as seen in the Upper Clinton section above. The underlying oölitic hematite of nearly 20.6 inches in thickness, as measured on an outside exposure at the Borst mine by the writer, is followed by 28½ feet of green shale interlaminated with dolomitic sandy lentils, which in turn is followed by suboölitic hematite ore (lean ore) 14 inches thick consisting of banded oölitic hematite and dolomite. Between the red flux and the suboölitic hematite bed, green shale predominates, with dolomitic sandy lentils from three to 12½ inches in thickness, aggregating a total thickness of seven and one-half feet.

Figure 11 Willowvale formation (Upper Clinton) at mine stripping, Clinton, N. Y. (Photograph by N. C. Dale)

Oölitic hematite. As this is the main ore bed about which Smyth (1892) and, later, Newland and Hartnagel (1908) have written, and from which so much has been mined in this area, it is judged sufficient here merely to summarize what has been done before.

The writer proposes to take up the following subjects, in the order of their importance: mineralogy, petrology, chemistry, and origin of the oölitic and red flux hematite zones. From study of the preceding members of the Sauquoit, we determined that the phosphatic and chamositic zones had been laid down as primary chemical and mechanical deposits in the bottom of a shallow sea, the former having been derived from decaying organic matter, and the latter from iron salts in the form of a hydrous aluminum silicate. The same general situation and origin characterizes the oölitic hematite zone, the iron content being undoubtedly of primary chemical origin, and deposited along with the associated shales and sandstone in shallow marine waters of upper Clinton times.

The accompanying map shows the location of the oölitic hematite zone in the Oriskany area. The best exposures, though none too good, along the line of outcrop occur where there has been active mining, such as the old Borst mine and stripping areas both to the south and to the north. In the exposures at the Borst mine can be seen the important elements such as the main oölitic zone, the lean ore zone, both of which belong to the Willowvale and the red flux above. As can be seen from the section, the main body of oölitic hematite rests upon a thin zone of reddish hematitic shale and measures 15.6 inches in thickness. Another bed of oölitic hematite is separated from this by a parting, and measures five inches in thickness, over which lies a banded dark dolomite and shale zone, with calcite, hematite, chamosite and disseminated pyrite, topped by a one-eighth-inch band of pyrite, so that the total oölitic hematite at the Borst mine outside exposure measures 20.6 inches, according to the writer, which probably is the upper bed. In the Clinton Metallic Paint Mine shaft, however, about one-half of a mile to the northeast, the oölitic hematite measures 24 inches in thickness. At no place was there more than a two-foot bed of ore noticed, although Smyth claimed that there were two beds of ore, a lower one of one foot in thickness and an upper one of two feet, with two feet of shale separating them.

The thickness of the oölitic hematite outside of the Clinton mines varies considerably. At Chadwicks, the writer measured 30 to 32 inches of oölitic hematite. At the Wells mine east of Clinton about half way between Sauquoit and Clinton where there is an open cut extending along the outcrop for several hundred feet Putnam reported 21 inches of oölitic hematite (Newland and Hartnagel, 1908, p. 62); Smyth's section (Kemp, J. F., 1895, p. 104) gives the following for the Franklin and Clinton mines:

Material	*Feet*
Calcareous sandstone and thin shale	50+
Nonoölitic ore (red flux)	6
Calcareous sandstone	6
Blue shale and thin sandstone	15
Oölitic ore	2
Shale	2
Oölitic ore	1
Blue shale and thin sandstone	100+

According to Newland and Hartnagel (1908, p. 62):

The red flux bed reaches its greatest thickness at this point. The oölitic ore alone is mined. The existence of two oölitic beds in the Clinton section has been generally accepted as a normal condition, but this is not the case. There is convincing evidence to show that the lower seam represents nothing more than a split in the main bed due to a thickening locally of the shale or sandstone parting that is nearly everywhere present. There are few places where the two beds are more than a few inches apart. As a rule the ore in this vicinity really measures from 30 to 36 inches, that is the combined thickness of the two beds, and it has been the recent practice to extract the entire oölitic ore without reference to the intervening rock layer.

Figure 12*a* shows microphotographs of the oölitic hematite, and figure 13*a* the chamosite zone. The Willowvale extending from the bottom of the oölitic hematite to the bottom of the red flux zone measures approximately 28 feet 11 inches in thickness, and consists largely of a main body of Willowvale shale and its intercalated sandy beds. South of the Borst mine, above an old tunnel, on the east bank of Mine brook and seven and one-half feet from the bottom of the red flux section is what we have called here the suboölitic hematite or lean ore zone, measuring 14 inches in thickness and consisting of banded oölitic hematite and dolomitic sandstone. Separating this from the red flux above is a series of pyrite-bearing dolomitic sandstone lentils alternating with shale totaling seven feet six inches in thickness, the dolomite beds measuring three, seven, eight and 12 inches in thickness. This zone Gillette calls the *Mastigobolbina typus* zone, and it has been correlated with the Irondequoit limestone and the Williamson shale at Rochester. Gillette believes that the main body of "oölitic" iron ore, or hematite, is not represented to the west beyond the limits of the Oriskany quadrangle. It is not the same iron ore that is mined at Verona. The iron ore at Verona occupies the same position as the Wolcott Furnace iron ore at the Sodus Bay area, and occurs at the top of the lower Clinton. Evidence tends to show

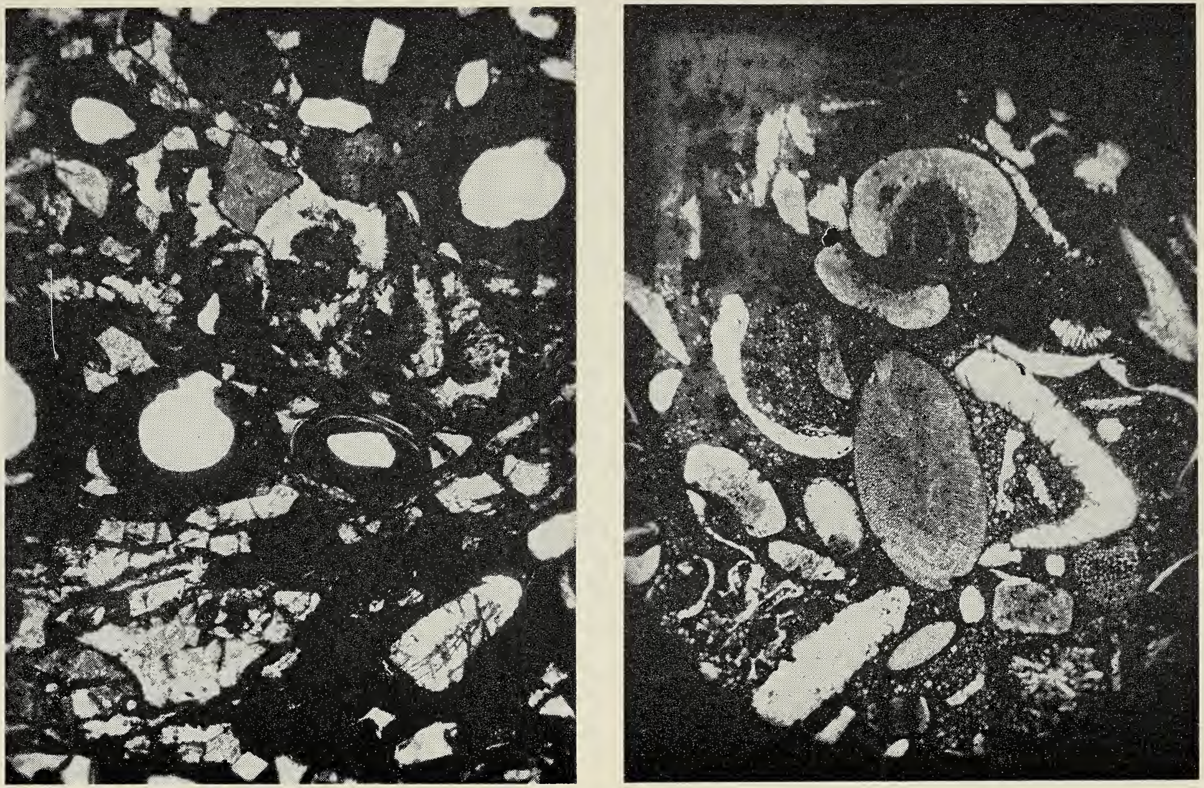


Figure 12 Microphotographs. Left, oölitic hematite with nuclei of quartz in groundmass of hematite and calcite, x 80; right, red flux showing hematite (dark) and calcite (light) in bryozoans and groundmass, x 80.

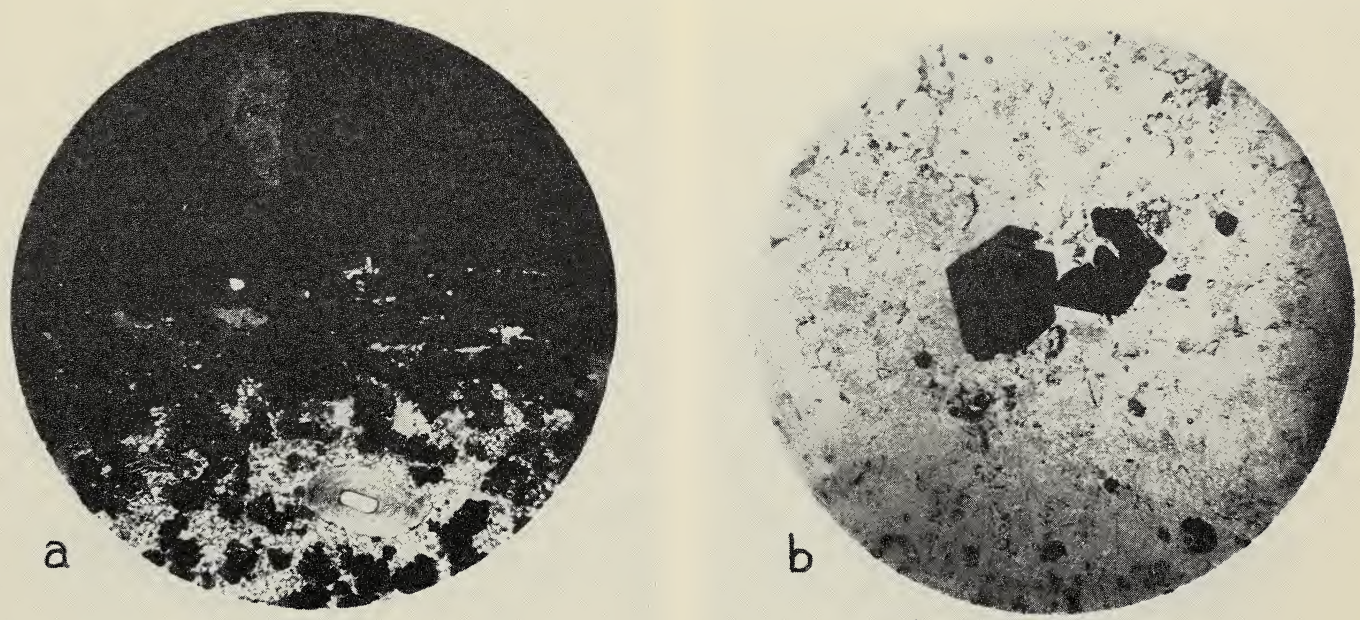


Figure 13 Microphotographs. *a* Pyrite band (dark) and disseminated pyrite (dark) at line of contact with dolomite stratum (light gray) granular part). Chamosite oölite with quartz nucleus in dolomite. Just above oölite hematite horizon in Willowvale at Borst mine, Clinton, N. Y., x 25.6. *b* Sandy dolomite (Herkimer) with pyrite crystals disseminated in groundmass of quartz grains and dolomite, x 25.6. Dawes Creek quarry, Clinton, N. Y.

that the oölitic iron ore at Clinton is more closely related to the overlying Willowvale shale than to the Sauquoit beds.

Gillette's personal communication regarding the Willowvale is as follows:

The Willowvale, a name which I am proposing as the eastern equivalent of the combined Irondequoit limestone and Williamson shale in the Rochester region, is a very interesting formation. This formation is the only eastern representative of the *Mastigobolbina typus* [zone]. It bears the same ostracods as the Irondequoit and the Williamson. As you will note from the Faunal Range chart, the six ostracods characteristic of this zone are *M. typus, M. trilobata, M. punctata, Plethobolbina typicalis, Beyrichia lakemontensis* var. *borsti,* and *Dibolbina clintoni.* These fossils do not have the same range. In western New York *Plethobolbina typicalis* is confined entirely to the Irondequoit. *M. typus* is found in the uppermost layers of the Williamson, *M. trilobata* ranges throughout the upper half of the Williamson and the Irondequoit, *M. punctata* is found sparingly to the very base of the Williamson but is more abundant in the upper portion of that shale and the overlying Irondequoit limestone, *Dibolbina clintoni* is confined entirely to the Williamson, and *Beyrichia lakemontensis* var. *borsti* is more common in the Williamson but is also found in the Irondequoit. In the Clinton area all these ostracods occur in the Willowvale. At the Borst mine the lowermost beds of the Willowvale contain both *Dibolbina clintoni* and *Beyrichia lakemontensis* var. *borsti.* This is the best place for collecting these forms. They were, however, found at other outcrops, but always confined to the lower layers of this shale. The other ostracods of this zone were found throughout the Willowvale.

What seems to have taken place is this. In the Rochester area we had the typical black graptolite-bearing shales being deposited at the beginning of *M. typus* time. At the close of the *M. typus* time the seas were depositing only clear limestone. The graptolites had entirely disappeared. Eastward from the Rochester area, conditions were different. Even as close as Sodus bay the typical graptolite-depositing conditions had given way to one in which a great variety of organisms were able to thrive. With the increase in the number of species the thickness of the shale also increased. In a like manner the Irondequoit changes eastward, and the crystalline limestone of the Genesee gorge gradually becomes a calcareous shale. The megascopic fauna also are different apparently due to ecology. These formations change progressively eastward and assume similar lithology. In the vicinity of Clinton the two formations can not be told apart. In fact I have not been able to separate them east of Fulton. At Clinton *Monograptus* once thought to be confined to the Williamson is found not in layers as in the Rochester region, but occurring sporadically throughout the whole thickness of the *M. typus* zone. Largely on this basis Ulrich thought that the Williamson, now known as the Willowvale, shale was the eastern equivalent of the Williamson, but since the ostracods common only to the Irondequoit are found in great numbers in the Willowvale, and since the two formations can be traced merging into a single formation, it is not thought wise to continue designating this shale as the Williamson.

Mineralogy and petrology of hematite zones. The ore known as the oölitic hematite is cherry-red to dull brownish in color, with the brownish tinge on the weathered surface, and the redder color on the fresh fractured surface. The red color is that of the amorphous, or earthy hematite. Due to this color, both the upper and the lower ore beds are naturally the most conspicuous part of these upper Clinton rocks. The texture of the rock of the main ore bed is oölitic, or, in other words, consists of minute concretions of subspherical to spherical and slightly lenticular shape, the oölites varying from a fraction of a millimeter to 4 mm in diameter. It has sometimes been described as the flaxseed ore, because of its resemblance to flaxseed. With the exception of shale partings, occasional pebbles of quartz and replaced crinoid columnals, gastropods and cephalopods, the oölitic zone consists essentially of amorphous oölitic hematite. Rarely does specular hematite appear and then as a band one-half of an inch thick within a vein of calcite, the outer walls of which consist of amorphous hematite. Under the microscope, and by incident light, the main oölitic mass shows less than 5 per cent of disseminated pyrite grains, or pyrite in the form of aggregations, or as nuclei for the oölites, or cement-filling. Some phosphatized fragments of Lingulae or trilobites are seen. Most of the opaque minerals are spherules of hematitic pigment.

Under crossed nicols the groundmass or cement appears to consist largely of calcite, with spherical to angular quartz grain nuclei, and aggregates of clastic quartz resembling sandstone. A few pebbles of shale also occur. Sometimes phosphatic fragments are seen as nucleuses for the oölites. Occasional crinoid or coral sections appear to be phosphatized with and without inclusions of quartz and pyrite. The phosphatized brachiopod fragments appear to be replaced by hematite along the edges, and also by ferric silicate, while the other fragments show a reticulate maze of green bladed crystals, the identification of which seems to be somewhat in doubt, though they resemble chlorite.

One of the specimens of oölitic hematite carries a thin band of specular hematite one-fourth of an inch wide which appears to be interbanded with amorphous hematite, calcite and disseminated pyrite. The specular hematite occurs as a band between an inner band of calcite and an outer wall of hematite. With the outer bands of amorphous hematite there are red lustrous transparent scales of goethite or hematite. Irregular grains and segregations of pyrite are found in the hematite, sometimes replacing it, or containing inclusions of the same. The hematite is also found replacing the calcite, so it would appear that these were contemporaneous in age with the pyrite and amorphous hematite. The specular hematite occurs as radiating acicular groups associated with blood-red tabular scales of hematite or goethite. In the banded amorphous hematite areas are found other thin bands of hematite, alternating with bands of calcite, both of which pinch and swell. Rounded quartz grains are found disseminated throughout the hematite, and in the calcite bands quartz appears as crystals. It would appear that in these series of minerals the amorphous hematite with its complement of detrital quartz is the oldest, the calcite, next and the specular hematite the latest, the calcite and the specular hematite not being separated by any great length of time. The quartz crystals associated with the carbonate bands vary from 2¼ to 7¼ mm in length, by 1½ to 2.7 mm in width, while the quartz grains range from 3¼ to 7.3 mm in diameter. The quartz nucleuses of the oölitic hematite, in which the above vein of specular hematite occurs, ranges from 1.7 mm to 3 mm in width, with envelops of hematite 1 mm thick, all of which is set in a ground mass of amorphous hematite. An occasional oölite of elliptical shape, but somewhat disrupted, shows a cross section consisting of finely laminated concentric brown phosphate bands .1 mm in thickness, enveloping .5 mm hematite bands, and these in turn enveloping a nucleus consisting of an aggregate of clastic quartz with disseminated scales of blood-red hematite or goethite. Other phosphate-banded envelops contain only hematitic nuclei, while other nuclei are made up of quartz and calcite aggregates, or entirely of quartz or carbonate. The nuclei are either spherical, or irregular lenslike bodies, disseminated in the banded amorphous hematite. In the ore zone at Lairdsville is a vein of calcite in oölitic hematite. Here the hematite is found enveloping rounded quartz grains, or as cement in the carbonate groundmass, and disseminations.

Blood-red transparent elongated tabular crystals of hematite or goethite are found associated with hematite, chlorite or carbonate, and radiating beyond the periphery of the oölites, or into the nucleus with chlorite and quartz. One oölite of chlorite aggregates surrounds eccentrically a segregation of calcite and hematite. Euhedral tabular hematite or goethite is found with chlorite, with an envelop of hematite. Another oölite, with a bean-shaped nucleus, contains several areas of quartz, with irregular tabularlike crystals of goethite or hematite pointing inward from the outer side of the nucleus. Other oölites consisting entirely of hematite contain nuclei of quartz, the outer edges of which have inwardly pointing crystals of goethite or hematite. Some of the important types of oölites are as follows:

Nuclei	*Envelops*	
	Inner	*Outer*
Hematite	Quartz	Hematite
Quartz	Hematite	Quartz
Hematite	Calcite	Calcite
Sandstone	Hematite	
Calcite	Chlorite	Hematite

One oölite contains a nucleus of hematite encircled by a thin band of quartz which in turn is enveloped by an outer concentric lamina of hematite. Still another shows a later and outer band of quartz than seen in the oölite just mentioned, with a nucleus of quartz. Some oölites are entirely of hematite, others with intermittent bands of calcite concentrically arranged or cutting across the oölite. One nucleus is phosphatic, with disseminated chlorite and a minute spherule of hematite. Most of the oölites, however, have homogeneous quartz nuclei while a smaller number have quartz aggregates resembling a small sandstone pebble. Some elongated aggregates of calcite are enveloped by hematite in the same manner as the normal oölite. Some oölites have calcite centers surrounded by chlorite bands, which in turn are enveloped by hematite.

The groundmass of the oölites is dominantly a carbonate, but whether it is a calcite, dolomite, or siderite is difficult to determine at this writing. It would appear that all three exist; certainly calcite appears, as shown by its low relief and lack of euhedral shape. Where the carbonate appears as well-formed rhombohedra, and in high relief, in all probability the mineral is siderite; but it is always much more difficult to decide where to draw the line between a siderite and a dolomite than to distinguish between a calcite and the other two.

Smyth (1892, p. 488) proved the concretionary structure of the oölitic hematite by lightly tapping the separated spherules on a steel plate with a steel hammer, which resulted in each spherule's breaking into a series of concentric shells until finally the nucleus of the rounded fragment of quartz appeared. The quartz nuclei generally contained, besides long needles of rutile and scales of hematite, inclusions of liquid and gas, proving its derivation from granitoid or schistose rocks. Smyth goes on to say:

> . . . on treating the spherules with hydrochloric acid, the iron is dissolved, and there is left a perfect cast of the spherule in silica, containing a little argillaceous material. This silicious cast, or skeleton of the spherule is, of course, transparent, and in it concentric

structure can be seen more perfectly than in thin section. The number of layers is seen to be large, often ten or more. With polarized light, silica appears sometimes to be amorphous, but usually gives aggregate polarization, like that often seen in chalcedony. Thus the two lower beds of ore at Clinton are truly oölitic, consisting of grains of sand inclosed in concentric shells of intimately associated ferric oxide and silica.

In the upper part of the Willowvale shale, between the oölitic hematite and the red flux, in what the writer has referred to as "the lean ore zone" or "suboölitic hematite zone" the hematitic oölites on the whole are not unlike those of the main bed below; and the groundmass is also carbonaceous although much more fossiliferous. Bryozoans occur partially replaced by hematite. The carbonate material is either a ferruginous dolomite or a siderite. Considerable disseminated pyrite occurs, and the hematite appears largely as pigment in the oölites. Some 95 per cent of the thin sections studied consist dominantly of ferruginous dolomite or siderite, with the normal hematitic oölite, and abundant relict oölites of chamosite replaced by calcite and chlorite. As stated above, this lean ore zone is 14 inches thick, and is essentially a fine and medium-grained, dark-banded ferruginous dolomite, with some oölites of hematite, phosphate and chamosite, and some disseminated pyrite. It is separated from the red flux bed by six to seven feet of pyrite-bearing sandy dolomite and shale, the sandy dolomite layers varying from three inches to 12 inches in thickness.

Overlying the Willowvale throughout the region in the Oriskany valley and the Sauquoit valley is a thick series of sandy shale and sandy dolomite, measuring 87½ feet thick in the College Hill section (Gillette, p. 48) and 78 feet thick in the Dawes Quarry Creek section (Gillette). These are found overlying what is commonly known as the red flux, which measures 4.7 inches thick in the College Hill section, and 2 feet 8 inches in the Dawes Quarry Creek section. The red flux between the Old Borst mine and the Dawes quarry measures between three and five feet thick.

The writer's examination of the red flux showed it to be essentially a hematitic, calcareous rock, with occasional geodes of strontianite, barite, celestite, calcite and dolomite. The hematite occurs as replacements of the calcite, and according to Foerste (1891, p. 28), who studied the ore, "the origin of the oölitic structures is not due to a concretionary segregation of iron particles, but . . . in the gradual replacement of the lime of the fragmental fossil bryozoans, particle after particle, by the iron ore." Smyth, after treating the samples of red flux with hydrochloric acid, found that

. . . the lime of the bryozoa has often been replaced not by iron alone, but by iron and silica, for there is left as a residue from this treatment a silicious cast of each fragment. In most cases the iron is removed from this by the acid, but in some samples the silica prevents the complete solution of the iron, even with prolonged digestion. Apparently there is an intimate association in the deposition of iron and silica (1892, p. 489).

The microscope shows that the amorphous hematite in the red flux is largely concentrated in the organic parts, and to a lesser extent, in the calcareous cement. The texture of the red flux is largely crystalline. The calcite occurs in the cellular parts of the organisms, and in the cement. Clastic quartz grains and some chlorite are also found. Most of the organic bodies are bryozoans and transverse sections of crinoid stems, for the most part calcitic as far as the internal structure is concerned with hematite concentrated in the external part. The writer was unable to detect or prove it to be siderite, though some of the rhombs might very well be that mineral. This description is based on the Borst Mine occurrence north of Dawes quarry.

In the east-flowing creek at Willowvale is found, at the spillway of the lower reservoir, a loose pile of blocks of oölitic hematite and fossil ore. Amorphous hematite is found enveloping the oölites and bryozoans as well. Fragmentary quartz enveloped by hematite occurs in irregular bands alternating with dolomite bands, dolomite being the predominant mineral of the rock. Chlorite occurs as nuclei of the oölites. Crystalline calcite is also found. Areas of clastic quartz and amorphous hematite, bryozoans and phosphatized fragments of Lingulae occur. From the appearance of the thin sections, it would seem that the rock was originally clastic with bryozoan fragments; but due to chemical changes it has been transformed into crystalline carbonate and iron oxide. Here again definite proof of the presence of siderite is lacking.

In the exposure at Clinton, the red flux has a much coarser grain, and the different forms of bryozoans can be separated without difficulty. According to Newland and Hartnagel (1908, p. 47) "the cementing material in both kinds of ore is granular calcite. There is considerable variation in the relative proportion of this mineral to the hematite. Local variation may be ascribed to the solution of the calcite after the ores were laid down, but it is also to be expected that the conditions of deposition would change from time to time and from place to place."

Chemical character of oölitic hematite and red flux. The Clinton ores show considerable regularity in their chemical composition (leaving out of consideration local beds which are generally too lean or too thin to be workable). The ores throughout the State may be said to average 40 per cent in metallic iron. Although these ores seldom run above 45 per cent or less than 35 per cent in metallic iron and average 40 per cent, the Clinton deposits at Clinton returned an average of 44 per cent through a period of several years. According to C. A. Borst the middle portion of the oölitic bed can be mined to yield 55 per cent, while if the whole bed is taken out without sorting, the average will be about 40 per cent.

The following analyses from A. H. Chester and E. W. Morley reflect the true composition of the ore.

	SMYTH BOTTOM TIER	BRITTON BOTTOM TIER	BRITTON FRANKLIN AND CLINTON	CHESTER GENERAL AVERAGE	MORLEY SOLUBLE AND INSOLUBLE	E. C. SULLIVAN RED FLUX
	1	2	3	4	5	6
Fe_2O_3...	69.17	42.97	79.98	63.	41.64	30.24
SiO_2....	11.57	29.72	9.98	12.63	4.18	8.71
Al_2O_3...	3.92	4.13	2.4	5.45	5.07	3.67
MnO...	.19	.37	tr	.15	1.06	....
CaO....	5.8	8.57	1.54	6.2	12.46	20.64
MgO...	2.27	1.96	.3	2.77	1.45	7.84
S.......	.28	.837	nil	.23	.02	.15 (SO_3)
P_2O_5....	1.726	1.534	1.239	1.5	1.01	.75
CO_2....	4.75	....	....	6.15	22.78	24.78
H_2O....	4.70	....	....	2.77	2.60	....
TiO_2....	....	....	....	....	.02	....
BaO....	....	....	....	....	.03	....
SrO.....	....	....	....	....	.05	....
Fe......	48.42	30.08	56.37	44.1	....	21.16
P.......	.754	.67	.541	.65	....	.327

Analyses 1 and 2, by Smyth and Britton, undoubtedly refer to the lower part of the ore bed. Number 3 must have been from a selected sample, while number 4 represents the average over a period of two years from the Franklin and Clinton mines, but made in 1873. Number 5 is an analysis, made by E. W. Morley for Smyth's study of chamosite (1917, p. 182). The insoluble and soluble percentages have been combined. This analysis is regarded as the most refined and probably the most accurate. Analyses 1, 2, 3, 4 and 6 are taken from Newland and Hartnagel (1908, p. 62-63).

The variation in iron content can be explained in part by the methods used in selecting the samples, and by the variation of the ore itself. The analysis of the red flux is interesting because of the lower iron and silica content, against the higher lime, magnesia and carbon dioxide content. It is certainly more calcareous than the oölitic beds. The percentages of phosphorus and sulphur are relatively high, a fact which is corroborated in part by the microscope, the phosphorus seldom running less than .25 per cent and ranging up to 2 per cent while the sulphur ranges from traces up to .5 per cent. The pyrite band found in the oölitic ore zone obviously accounts for some of the sulphur. Most of the silica occurs in the oölitic zone in the form of quartz, which ranges from 2 to 15 per cent. The red flux accounts for 7 to 8 per cent of the silica, while part of it, occurring as quartz, is found in amounts up to 2 or 3 per cent combined with aluminum in the form of clay. Of course some of the silica may be found in the chamosite zone which, along with the pyrite, is frequently included in the ore. The lime and magnesia included in the ore would account for the calcareous and dolomitic parts of the red flux zone. The red flux accounts for nearly 20 per cent of the lime, while the oölitic hematite accounts for 10 to 12 per cent.

Physical conditions during deposition of iron ore beds. The oölitic hematite and the red flux have been found to be integral parts of the upper Clinton group of central New York.

From the work of others, as well as from the present study it is clearly apparaent that the oölitic hematite was deposited contemporaneously with the confining beds, and not formed subsequently to them. The clear line of demarcation between the oölitic hematite and the overlying and underlying shales definitely indicates primary deposition of detrital quartz, and chemical precipitation of the iron oxide and the colloidal silica, the detrital quartz appearing as nuclei for the spherules and the rest of the quartz as concentric laminae, as demonstrated by Smyth (1917, p. 448). The ripple and channel marks found so abundantly in the overlying and underlying lentils testify to the shallow water conditions at the time of deposition. Another evidence of the essentially marine character of the formation is seen in the fossiliferous dolomite and sandy beds of this area. The oölitic bed, apparently, is essentially a clastic chemical deposit made when the lagoonal sea bottom was essentially stable and while solutions containing iron were being deposited on the sandy bottom. Muds represented by the shale partings in the ore appear as interruptions in the chemical cycle, which was brought to a close by another mud deposit toward the top. This, because of the chamosite and pyrite present, apparently indicates a different chemistry for its deposition. It is not known whether this pyrite lamina is uniformly distributed throughout the Oriskany area, although it was quite common in the old Borst mine. Such a seam could have been derived from decaying organic matter on the sea bottom in the presence of iron salts in the water. According to Hayes (1915, p. 90-91), the iron sulphide such as is found in the Wabana iron ore might have been deposited as

> . . . the higher sulphide (FeS_2) or as ferrous sulphide (FeS) and free sulphur, the higher sulphide forming by subsequent diogenetic processes. In either case the evidence indicates that the essential constituents were present in the original sediments, and that the pyrite occurs as a primary bedded deposit. The formation of ferrous sulphide in the bottom deposits of the Black sea is described by N. Androussow (1897, p. 7). He found that a micro-organism *Bacterium hydrosulphuricum ponticum* liberates hydrogen sulphide not only from albumenoids, but also directly from sulphates and sulphides, and ferrous sulphide results from the action of hydrogen sulphide on iron salts. Other micro-organisms, as yet insufficiently studied, also occur in the Black sea. In depths of 300 to 717 fathoms two varieties of mud were found, a viscous sticky black mud holding iron sulphide (FeS), and a less dense blue mud holding pelagic diatoms, a smaller quantity of FeS, and concretions of FeS_2. The blue mud is thought to underly the black mud. Thus the fact is established that FeS_2 is produced in bottom deposits of the Black sea, at depths of 300 to 717 fathoms.

A further discussion of iron sulphide is given by Hayes (*ibid.*).

The exact mode of formation of this Black Sea iron sulphide, is not definitely known. Doss (1912, p. 463-83) concludes that iron sulphide and free sulphur may form in modern deposits through the agency of these desulphurizing bacteria, but he does not state whether the bacteria actually precipitated the iron sulphide, or whether they produced the iron hydrate, which, being acted upon by H_2S, produced the hydrated iron sulphide.

Conditions for formation of the chamosite are manifestly different from those for the pyrite, although apparently there was a recurrence of the same hydrous aluminum silicate of iron, once just below the oölitic ore, and again above it, and there is still another higher up in the lean ore zone. The two latter occur in the Willowvale shale.

The marine environment is well brought out by the hematitic orthoceratites and brachiopods, and the phosphatized invertebrate remains found occasionally through the ore; and, of course, the great wealth of fossils of marine habitat found throughout the Willowvale reveals conclusively the environment under which the ore was laid down.

Evidence in favor of primary deposition of iron ore beds. Through the sorting action of salt water, fragments of invertebrate skeletons and pebbles were deposited on the floor of a lagoon which was receiving waters from adjoining ancient land masses, both to the north and to the east. These waters contained, in addition to carbonates of lime and magnesia, certain amounts of iron or silica in the form of colloids. Agitation in these lagoonal waters caused by wave or current action would be responsible for the uniform distribution of the clastic and chemical deposits. In any case, the materials constituting these strata were entirely different from the underlying shale, thus accounting for the sharp line of demarcation between the oölitic stratum and the underlying shale within the oölitic stratum. Sorting action of the constituent particles is clearly in evidence, as shown by the stratiform bands of pebbles coated with hematite. This same action has resulted in the parallel arrangement of the oölites. Although it is possible to find the oölites differently oriented, most of the discoidal oölites lie with their long diameters parallel to the bedding. The oölites range in size from ½ to 1½ mm in diameter, while pebbles of quartz generally exceed 5 mm.

Muds were accumulating during the deposition of the oölites, as shown by the more or less discontinuous shale partings in the oölitic hematite. Smyth (1892, p. 143, 487) gives the following picture of the deposition of these ores:

By reference to a geological map of the eastern United States, it would be observed that the Clinton beds were deposited in the sea which received the drainage from an extensive area of crystalline rocks. Long continued denudation of these rocks, which are made up in part of iron-bearing silicates and included important bodies of magnetite and pyrite, set free large amounts of iron to be carried seaward in solution or suspension. Along the coast of the sea there were in Clinton times extensive swamps and mud-flats, evidence by the frequent surface markings, cracks and tracks of crustaceans, and worms found in the shales and sandstone. In other places calcareous fossil fragments accumulated and were rolled about and ground by the waves, and finally deposited in shallow water, forming shell beaches, similar to those of the present day, for example, the coquina on the Florida coast. Most of the iron brought down by land-drainage would be wasted, but a part would be precipitated to form the ore beds. The precipitation occurred in two ways, thereby giving rise to two ore varieties. Where the waters were collected in partially or completely inclosed basins, the iron was thrown down by slow oxidation and gathered layer on layer about the sand grains, thus forming the oölitic ore. The conditions requisite to this method of precipitation obtained apparently over no great areas, so that the oölitic beds are generally of limited extent. Again the ferruginous waters came into contact with the calcareous shell fragments; here the iron was precipitated partly by reaction with the lime carbonate, yet mostly by oxidation, while the lime was carried off in solution by the aid of the carbon dioxide set free. As this process took place while the shells were being rolled about, or heaped up in loose aggregates, and was chiefly a result of oxidation, the iron took the form of oxide rather than carbonate. It need scarcely be stated that this method of replacement is widely different from the other process of replacement that has been applied to the ores. The progress of the reaction advanced step by step with the accumulation of the fossil fragments. Thus while the iron is a secondary product as regards the particles of ore, it is primary in relation to the ore-bed itself. After the ores had thus collected into loosely aggregated masses of grains and altered fossils, they were compacted into beds, and covered by muds, sands, and lime oozes, which eventually became shales, sandstones and limestones. As a result, the grains and fragments rich in iron are frequently surrounded by pure calcite, a circumstance that is far from being opposed to the present theory of ore formation, but rather in line with what one would expect.

Most of the iron was precipitated, probably as the hydrated oxide, as has been suggested by Newland and Hartnagel (1908, p. 53) ; and its change from limonite to hematite took place as a result of static pressure, which of course resulted in the dehydration of the limonite after uplift. According to the authorities cited:

The New York Clinton beds in common with those of Ohio, Ontario and Wisconsin, were deposited along the northern margin of the interior Mississippi sea, and the ferruginous materials must have been derived largely from the wash of the Pre-Cambric land mass of the north and northeast.

The New York section has its maximum development in the stretch from Clinton to the west end of Oneida Lake, where there was apparently an embayment curving around the southwestern border of the Adirondacks. The present outcrop in this part is everywhere within fifty miles at most of the crystalline area.

Mineralogy of red flux horizon. This horizon as studied at Clinton measures six feet in thickness at the Dawes Quarry Creek section, a measurement which includes dolomitic zones at top and bottom. It is essentially a bryozoan reef changed to hematite, in which the amorphous and crystalline hematite has replaced the walls and intercellular areas of the bryozoans and other organisms. The same mineral occurs in the cement adjacent to the organisms. Hematite under the microscope is seen either as amorphous pigmented grains, or blood-red translucent scales, or more rarely, as splendid lustrous metallic crystals, but it is difficult to distinguish goethite from hematite in all cases, since both consist of blood-red scales. Generally these scales are shapeless, although there are a few of euhedral shape, which take after the 010 face of goethite, or a cross section through 011 and 010, or the profile of a rhombic form of hematite. The scales are too small for more definite optical determination.

Occasional grains of pyrite and considerable stain by limonite occur in the central parts of the ore. Sometimes whole cross-sections of bryozoans appear to have limonitic cell walls, with calcite occupying the internal parts of most organisms, either as an aggregate mosaic structure of anhedral grains, or as a dominating element in the more stratified areas. The rock itself responds quite violently to the acid (HCl) test.

Siderite, as numerous small rhombs of high relief and ash-gray color, is found imbedded in a hematitic cement enveloping the organic parts of the rock. As calcite rarely occurs as euhedral grains in these rocks, it is a fair question whether these rhombs identified with siderite above are dolomite, ankerite, or siderite; but their high relief and ash-gray color seem to favor siderite. Chlorite as cores and general background for inward pointing blood-red scales of goethite or hematite are found in some organic bodies and even in oölites. Its reticulate nature and nearly Berlin-blue color under crossed nicols would suggest clinochlore. Quartz as pebbles, or aggregates of clastic quartz, or as filling for the cells of bryozoans, is sometimes found. Other minerals found in the red flux zone are: strontianite, celestite, barite and pyrrhotite; the first two occurring directly in the red flux, while the latter two are found in the Herkimer sandstone. Some of the strontianite reported to have come from the Clinton mines has, however, upon investigation turned out to be earthy barite, which occurs as small, opaque white tufted rosettes on scalenohedra of calcite, or in fibrous, somewhat reticulated masses as filling for geodal cavities. Morley reports 0.03 of BaO in his analyses of the oölitic hematite (cf. p. 80). In the same analyses SrO is noted. Smyth noted strontianite near the Lairdsville quarry (1911, p. 156). Celestite has been found in the red flux and the Lockport, occurring in the former as tabular crystals 2 cm by 1 cm by 1 mm, with prominent 001, 102, 104 and 011 faces, which are found in replacement geodal cavities, the outer walls of which are lined with pyrite, calcite, dolomite and amorphous hematite.

Pyrrhotite, although rarely found in sedimentary rocks, was long ago noted by Smyth (1911, p. 156-160) one-half a mile east of Lairdsville in the upper part of the Clinton in the red flux. Crystals range in size up to about 5 mm in diameter, and while some of them have the normal yellow-bronze color, they are more commonly tarnished or superficially altered to limonite, and range from yellowish brown to black in color, often with strong iridescence. For further details the reader is referred to the above reference. Apparently these rusty grains are pseudomorphs of limonite, and possibly pyrite, after pyrrhotite. Smyth (1911, p. 159) says. "Evidently the limonite pseudomorphs have sometimes formed directly from the pyrrhotite, and again, they have followed upon the conversion of the latter mineral into pyrite, the former case giving more perfectly formed pseudomorphs." Its occurrence in the Clinton is difficult to explain even though considerable experimentation has been done in the laboratory.

Herkimer Sandstone of Uppermost Clinton

Overlying the red flux, and usually considered as a subdivision of the uppermost Clinton, is a variable series of highly fossiliferous sedimentary rocks, for the most part sandy shales and sandy dolomites, known as the Herkimer sandstone. This ranges in thickness from 41 feet six inches in the Rogers Glen section at Willowvale to 78 feet at the Dawes Quarry Avenue section, and 87 feet six inches in the College Hill section. In his "Generalized Correlation Diagram of the Clinton between Rochester and Clinton" (figure 14) Gillette agrees with Ulrich in correlating the Herkimer sandstone with the Rochester shale, and places it in the Paraechmina spinosa ostracod zone (Gillette, 1940, p. 22). Most of the fossils in this zone come from the sandy shales, although some have been found in the heavier dolomitic beds. These beds consist essentially of pyrite, quartz and dolomite, which, after several years of weathering, give the characteristic brown coloring so beautifully exemplified in the Hamilton College buildings. In the Dawes Quarry section these dolomite strata measure from an inch to 19 inches in thickness, the thickest beds being of the greatest economic value. In the series above the quarry section, and west of the bridge over Dawes creek, is a one and one-half foot layer of rippled hematite-banded, sandy dolomite, with hematitic bryozoans. (Figures 15 and 16 show the zones above and below the red flux at Clinton and Chadwicks.) From crest to crest the ripples measure 19 to 44 inches, suggesting pararipples. Three feet above this dolomite occurs another rippled hematite bed, largely in the form of a dolomitic conglomerate. The accompanying six-foot section, observed by the writer, shows at a glance the nature of these beds.

6 feet	4 Hematitic dolomite 3 Hematitic dolomitic conglomerate 2 Sandy shale 1 Banded dolomite

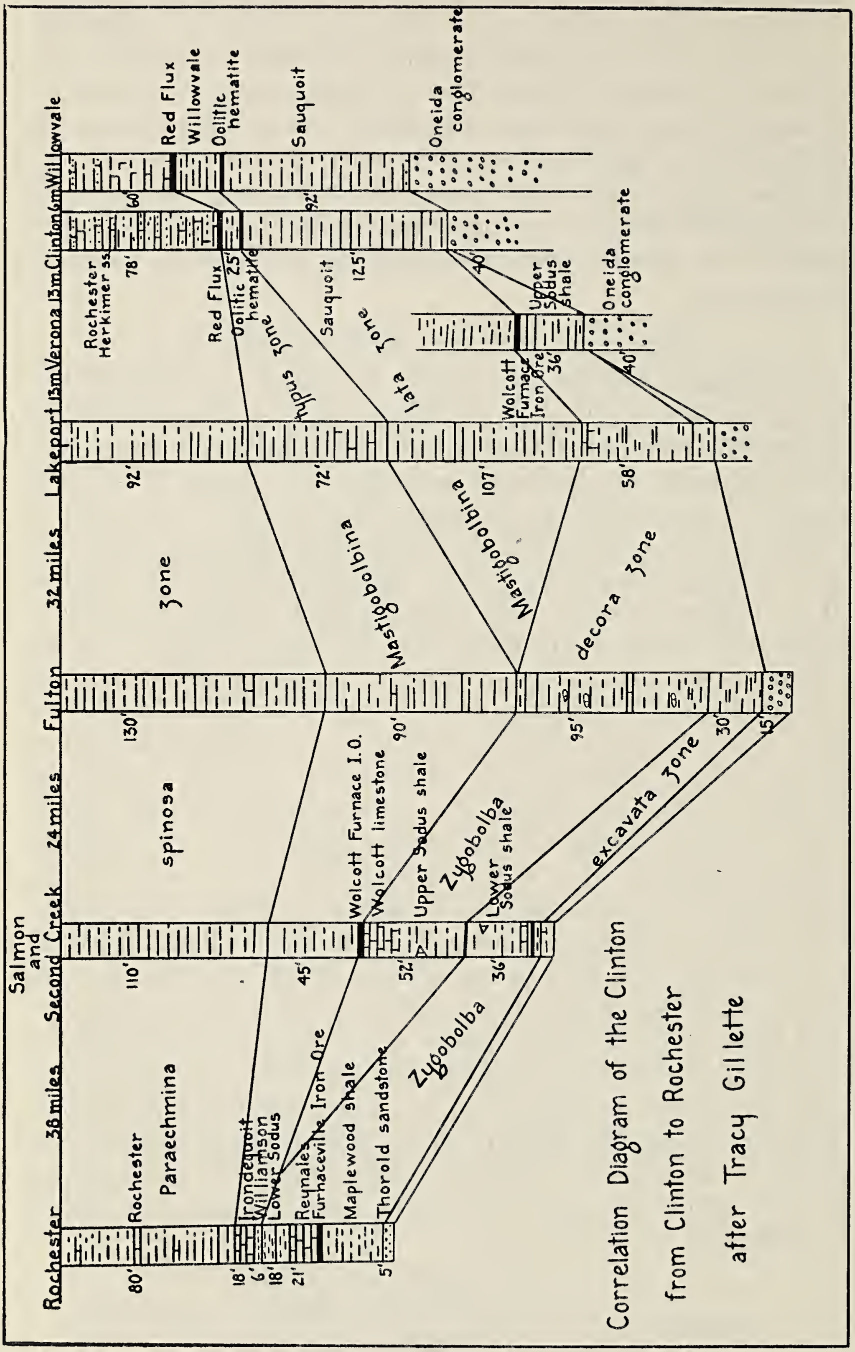


Figure 14 Correlation diagram of the Clinton from Clinton to Rochester. (After Tracy Gillette)

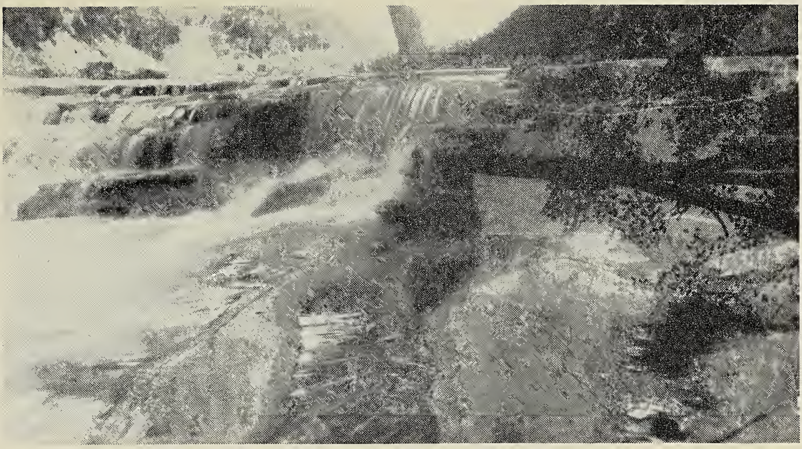


Figure 15 Pararipple marks just below the red flux in Clinton dolomite (Upper Clinton); the red flux forms the crest of the falls. Just east of Clinton. (Photograph by D. R. Meredith).

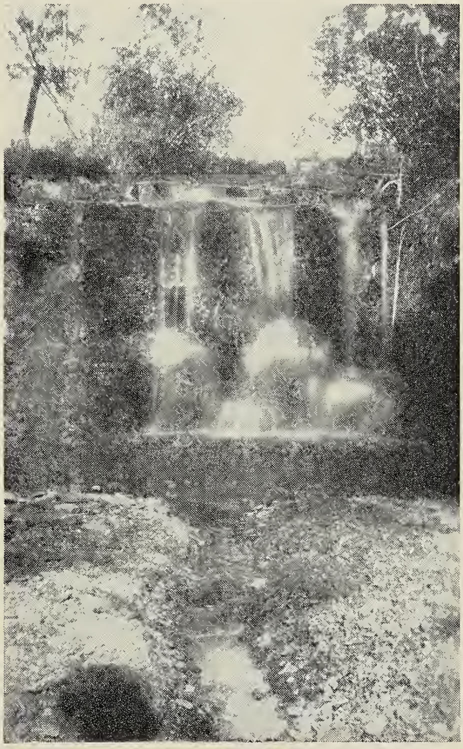


Figure 16 Buttermilk falls, Chadwicks, N. Y. The red flux zone forms the crest of the falls. (Photograph by D. R. Meredith)

In the College Hill and Willowvale sections overlying the red flux a slightly different expression of sedimentation was found.

Conspicuous in the College Hill section are some massive dolomites, hematitic sandstones and bluish sandy shales. The lowermost dolomite, slightly hematitic in nature, is a massive four-foot bed, cut by vertical joint planes (N. 10° W. and N. 15° E.). The upper surface is prominently glaciated and shows striations, running S. 8° E. For 15 feet above this stratum is a series of gray dolomitic shales, and sandy shales with lentils of sandy dolomite. Above this series is a 16-inch stratum of red hematitic sandstone, which underlies a bed of massive hematitic dolomite carrying bryozoans. This stratum shows joint planes extending N. 25° W., N. 40° W., and N. 65° E., and the surface is also glaciated. Between the dolomite stratum and the lowermost algal reef of the Lockport is a series of rarely fossiliferous blue or green fissile shales, with dolomite carrying sphalerite (ZnS). For the paleontology of this section, see Gillette's measured section on page 98. The uppermost layer of the Clinton, referred to above, is a brownish weathering sandy dolomite averaging four inches in thickness and carrying sphalerite and pyrite, the pyrite enveloping sphalerite which in turn incloses quartz. Above this formation, the sediments seem to be entirely different paleontologically and lithologically; therefore, it is concluded that the contact between the Clinton and the Niagara should be located here.

Paleogeography of the Clinton group. The Clinton group constitutes the lower portion of the Niagaran series but as we have already indicated neither the bottom nor top of the Clinton shales is present at Clinton village.

It is believed that the Silurian Sea, in which the formations of the Niagaran series, as well as those of the Cayugan, were deposited at the beginning of the Paleozoic era, was separated from the Atlantic basin by a broad northeast-southwest barrier extending from New Brunswick and Laurentia on the north to northern Alabama on the south. This barrier at the close of the Ordovician must have increased in area as the result of the Taconic orogeny, which caused the sediments that had been accumulating in the geosyncline along the shores of the old land mass on the north and barrier to the south to be upraised and folded. Such a folded area is seen in the Taconic range in the eastern part of New York State. In our own area, this mountain-making movement is reflected in the disconformity between the Oneida and Frankfort.

Much of the Silurian sediments are of shallow water origin, the coarser conglomerate at the base of the Silurian, the Oneida, being derived from the eroded land masses to the north and east and forming the littoral facies of these marine deposits. The overlying and predominating shales of the Clinton with their sandy dolomitic and ferruginous members show unmistakable evidence of shallow-water conditions, as we have already indicated, and properly belong in the littoral facies along with the Oneida conglomerate though considerable oscillation is shown by the alternating shale and dolomite strata from top to bottom. The hematite, phosphate and chamosite members of the formation, although in large part chemical, show very clearly their primary sedimentary nature, the oölitic structure being essentially mechanico-chemical in origin. Furthermore, the red flux of the Clinton is mechanico-organic in part as shown by the fragments of fossils included among the clastic components of the formation, this fragmentation being due to the action of the waves as they washed upon the old shore. Throughout the Clinton are abundant records of shore features, such as ripple, rill and channel marks, mud cracks, shrinkage cracks and tracks of worms and crustaceans, the latter particularly common in the Herkimer sandstone and the former in the Middle Clinton beds. Newland and Hartnagel (1908, p. 14) describe the conditions of origin for the Clinton as follows:

During Clinton times there seems to have been an approach to the conditions which later in the Salina age led to the extensive deposition of salt and gypsum. These conditions may have been initiated even as early as Medina time. Salt springs are found not infrequently along the outcrop of the Medina sandstones and in such a state of concentration that they were once used commercially for the extraction of salt. Their presence, even if not due to included beds of rock salt, which so far have never been discovered, indicates a high degree of salinity for the waters, that is likely to have been brought about by evaporation in basins shut off from free communication with the sea. The deposition of the Clinton hematites required a similar concentration, as will be explained later. . . .

The existence of shallow waters, sheltered bays and lagoons requisite to the accumulation of deposits like those characteristic of the Clinton formation may be considered as indicative of an extensive coastal plain stretching southward from the ancient land masses—the Laurentian and Adirondack areas. Such a coastal plain had been built up from the wash of the lands during the long interval from Potsdam to Medinan time. During the Medina age there must have been a gradual sinking of this platform with the progress of sedimentation, and the subsidence continued into Clinton time, though not on the same scale.

Such a sinking was not entirely continuous, though on the whole, the Clinton section in this area represents a transgressive series consisting essentially of clastics in the lower part and calcareous and dolomitic members in the upper part.

According to Newland and Hartnagel we have little information as to the northern limits of the shore line during Clinton time. They state (1908, p. 15) as follows:

Since the uplifting of the strata, they have been continuously subjected to erosion and their outcropping portions worn back until they are now considerably south of the original limits. It seems scarcely probable, however, that the Clinton beds ever extended so far north as to overlap on the crystallines, since this would involve the removal of more than 100 miles of rock on the western end of the belt, between the present line of outcrop and the southern edge of the Canadian Pre-Cambric area.

The source of the materials comprising the Clinton strata must have been the Precambrian crystallines and the overlapping pre-Silurian sedimentaries though the iron of the hematite zones must have been derived from the gneisses and schists which contain both free and combined iron ores.

Just which form the iron minerals assumed after being set free is not definitely known but it is believed they must have existed in the state of either a ferrous carbonate or possibly as a sulphate. The conversion of the soluble form of iron to the first precipitated form can not be determined precisely, though Spring (1899, p. 47-62) claims that since the "ferric hydroxide will become dehydrated in salt water and form ferric oxide, the view may be taken that some of the iron may have been precipitated as ferrous hydrate and formed the ferric oxide directly." It has already been noted that the chemistry involved in such minor elements of the Clinton as the chamosite and the phosphate of lime must have been very complex.

In the absence of evidence of iron bacteria as in the case of the Wabana, Newfoundland ores, claim can hardly be made to any obvious organic evidence of origin though the possibility of bacterial action playing a role in the initial precipitation will ever confront the geologist interested in the origin of iron ore deposits.

Paleontology of the Clinton group. One who has seen the Clinton in the field for many years can not help but be impressed by the great variety and abundance of species found in certain members of the Clinton. Figures 17-26 illustrate the variety of life found in the various members of this formation. The weathered rusty dolomite so common along the Stebbins Creek section, as well as to the south and east of the Borst mines, yields enough of the characteristic Clinton life to make visits to such places of great interest. For

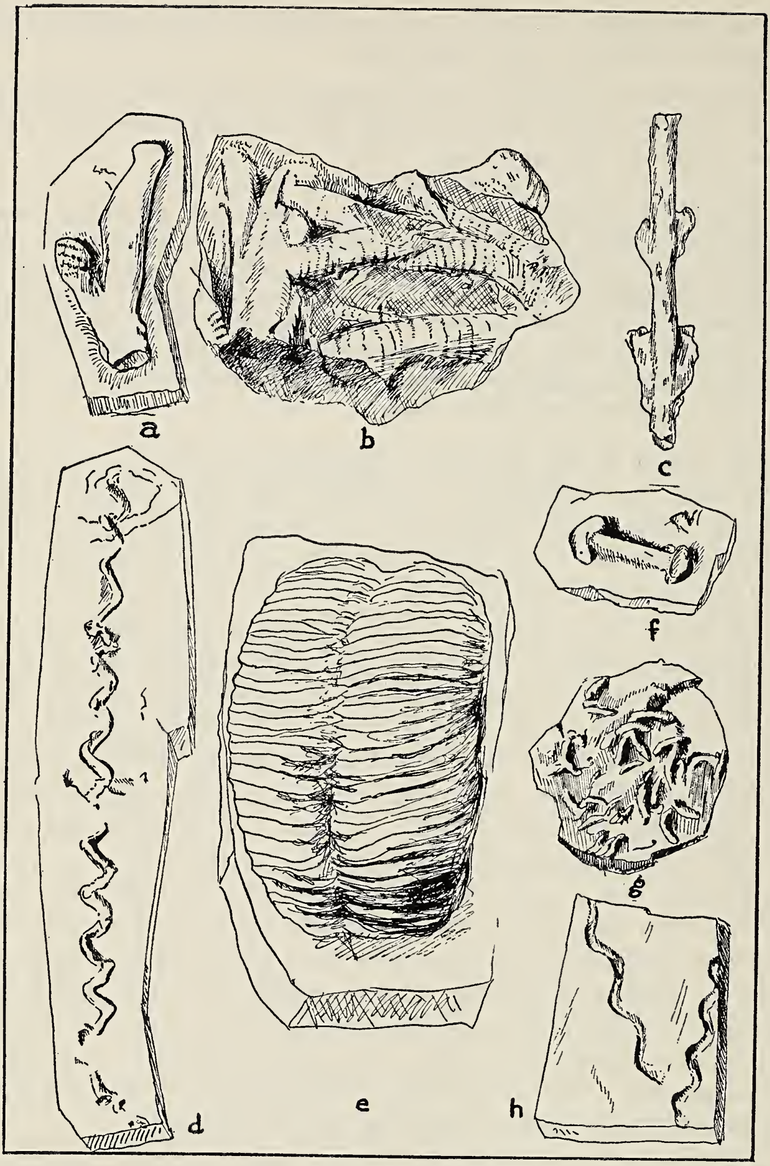


Figure 17 Clinton fossils. (Sea weeds *a, b, c, e, g;* worm burrow *f;* trail of gastropod *d, h.*). *a Buthotrephis impudica. b Arthrophycus alleghaniensis. c* Stem of sea weed? *d* Trail of gastropod. *e Rusophycus biloba. f* Worm burrow. *g* Stems of marine plants? *h* Trail of gastropod, Herkimer sandstone. (Drawn from specimens by V. Caldwell)

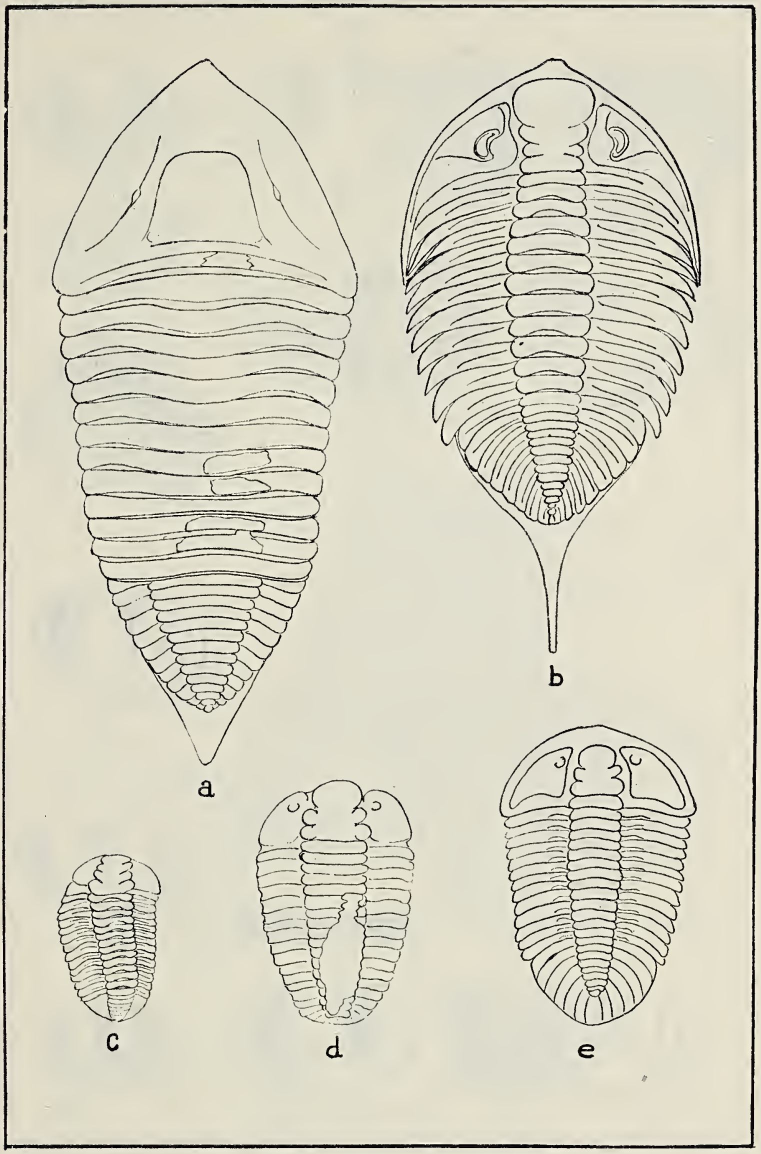


Figure 18 Clinton trilobites. *a Homalonotus delphinocephalus,* x ½. *b Dalmanites limulurus. c Liocalymene clintoni. d Calymene conradi? e C. niagarensis.*

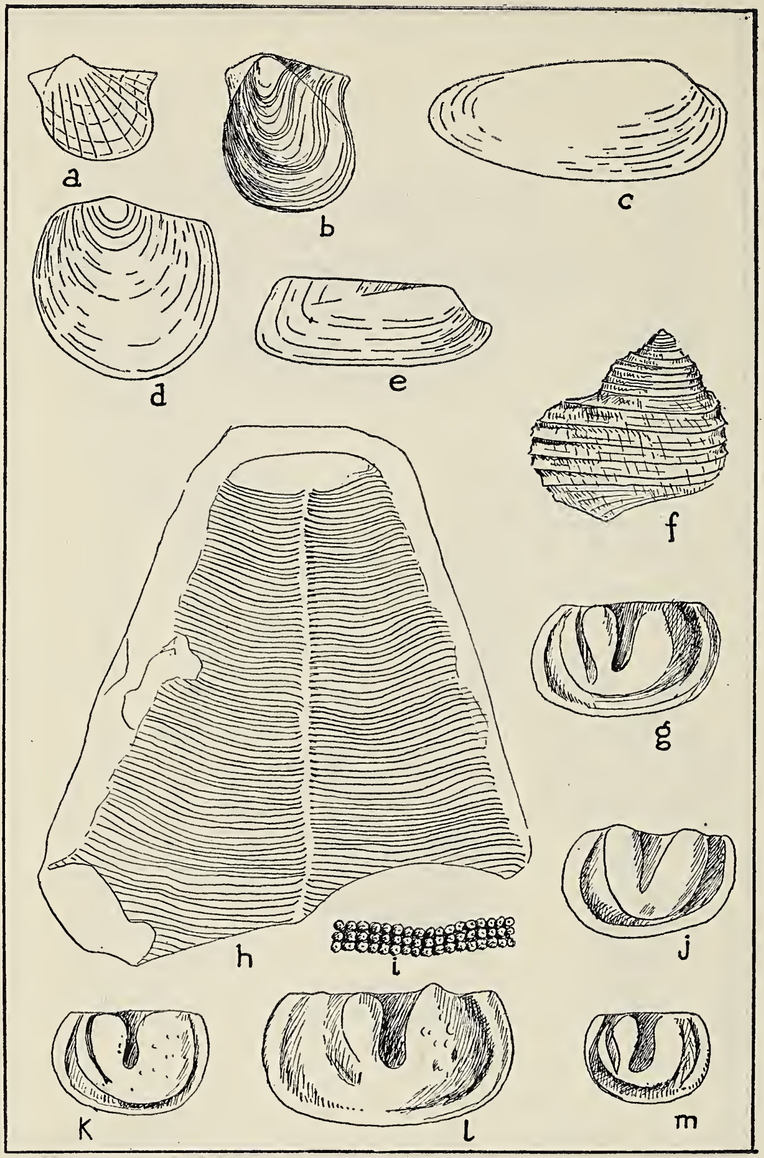


Figure 19 Middle Clinton fossils. (Pelecypods *a-e;* gastropod *f;* conularids *h, i;* ostracods *g, j-m*). *a Pterinea emacerata. b. Leptodesma rhomboidalis. c Ctenodonta machaeriformis. d Cyrtodonta alata. e Orthonota curta. f Cyclonema varicosum. g Mastigobolbina lata;* squeeze of right valve; x 8. *h, i Conularia niagarensis;* with surface detail x 5. *j Zygobolbina conradi;* squeeze of right valve, x 8. *k Mastigobolbina clarkei;* squeeze of right valve, x 8. *l M. vanuxemi;* natural cast of interior of right valve, x 8. *m M. lata;* squeeze of right valve, x 8. (Drawings by V. Caldwell)

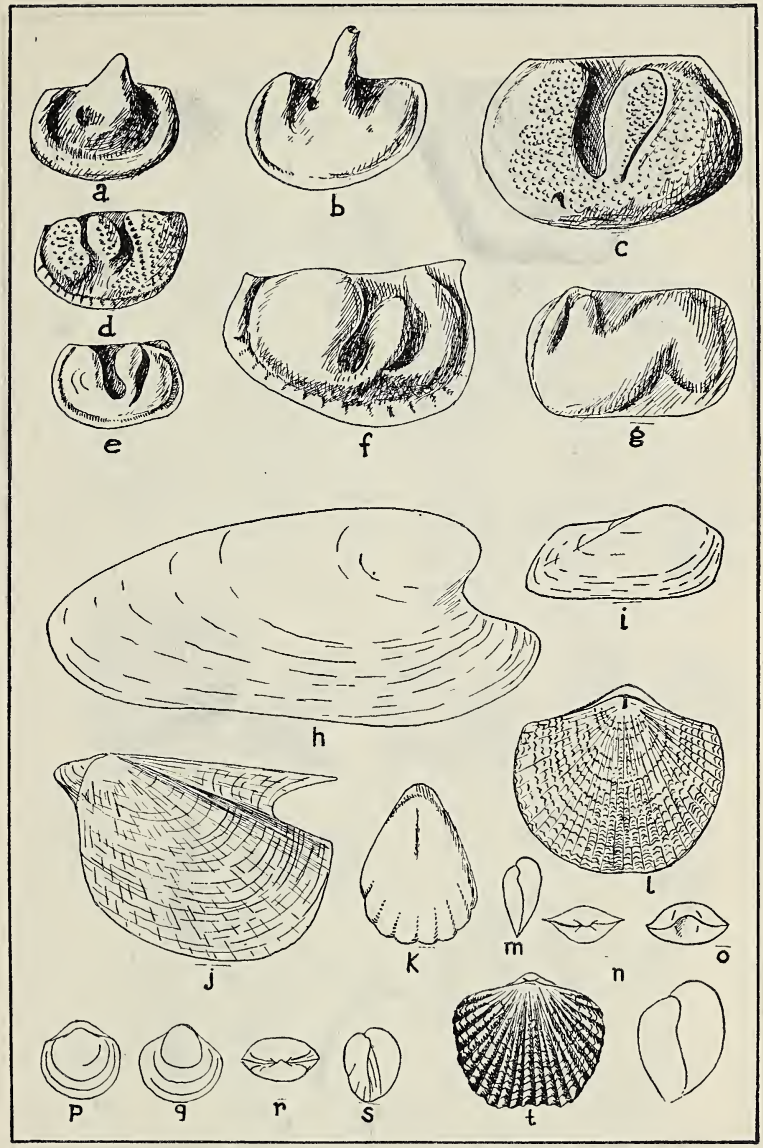


Figure 20 Upper Clinton fossils. (Ostracods *a-g;* pelecypods *h-j; brachiopods k-u*). *a Paraechmina spinosa,* x 20; right valve. *b P. postica,* x 20; right valve. *c Mastigobolbina punctata,* x 20; right valve. *d Beyrichia veronica;* testiferous right valve, x 20. *e. Mastigobolbina trilobita,* x 12; testiferous left valve, male. *f Beyrichia lakemontensis* var. *horsti,* x 16; left valve, male. *g Dizygopleura proutyi,* x 20; left valve, male. *h Modiolopsis valida. i M.subcarinata. j Pterinea emacaeata. k Camarotoechia acinus. l, m, n, o Atrypa reticularis. p, q, r, s Nucleospira pisiformis. t, u Atrypa nodostriata.* (Drawn by V. Caldwell)

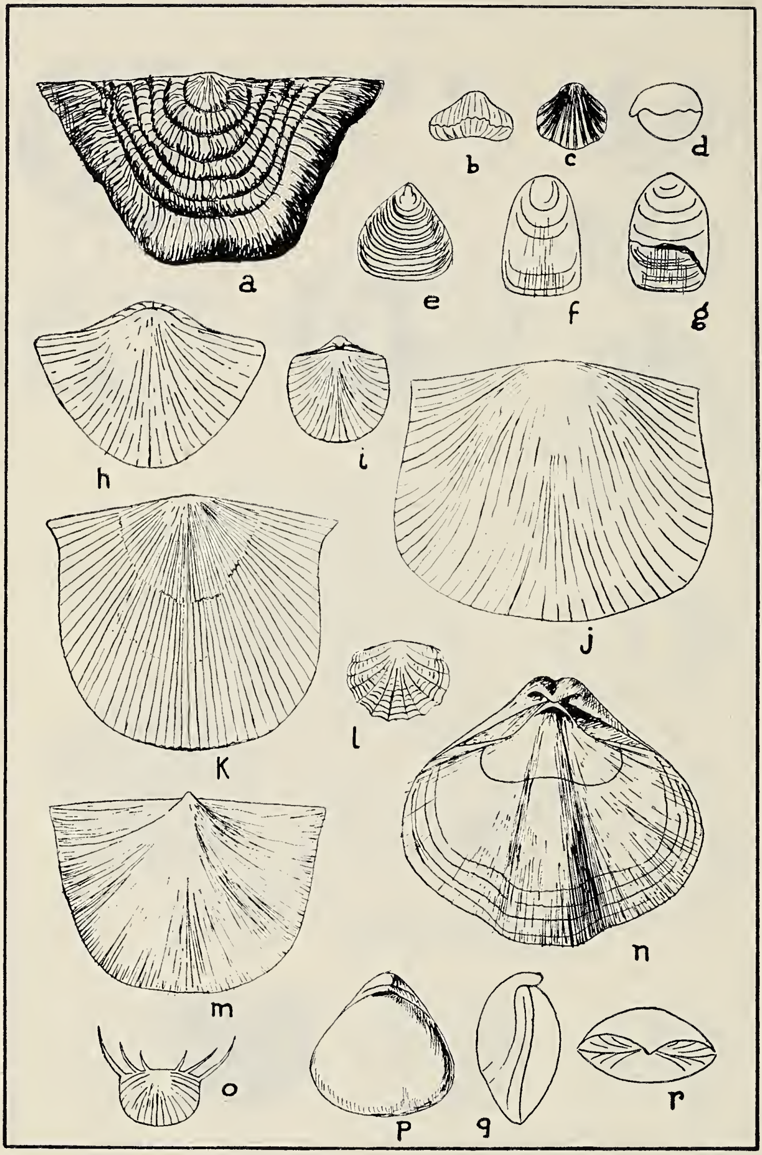


Figure 21 Upper Clinton fossils. (Brachiopods *a-r*). *a Leptaena rhomboidalis. b, c, d Camarotoechia neglecta. e Lingula perovata. f Lingula clintoni. g L. oblata. h Plectambonites transversalis. i Dalmanella elegantula. j Strophonella patenta. k Schuchertella subplana. l Coelospira hemispherica. m Rafinesquina obscura. n "Spirifer" radiatus. o Chonetes coxnutus. p, q, r Whitfieldella intermedia.* (Drawings by V. Caldwell.)

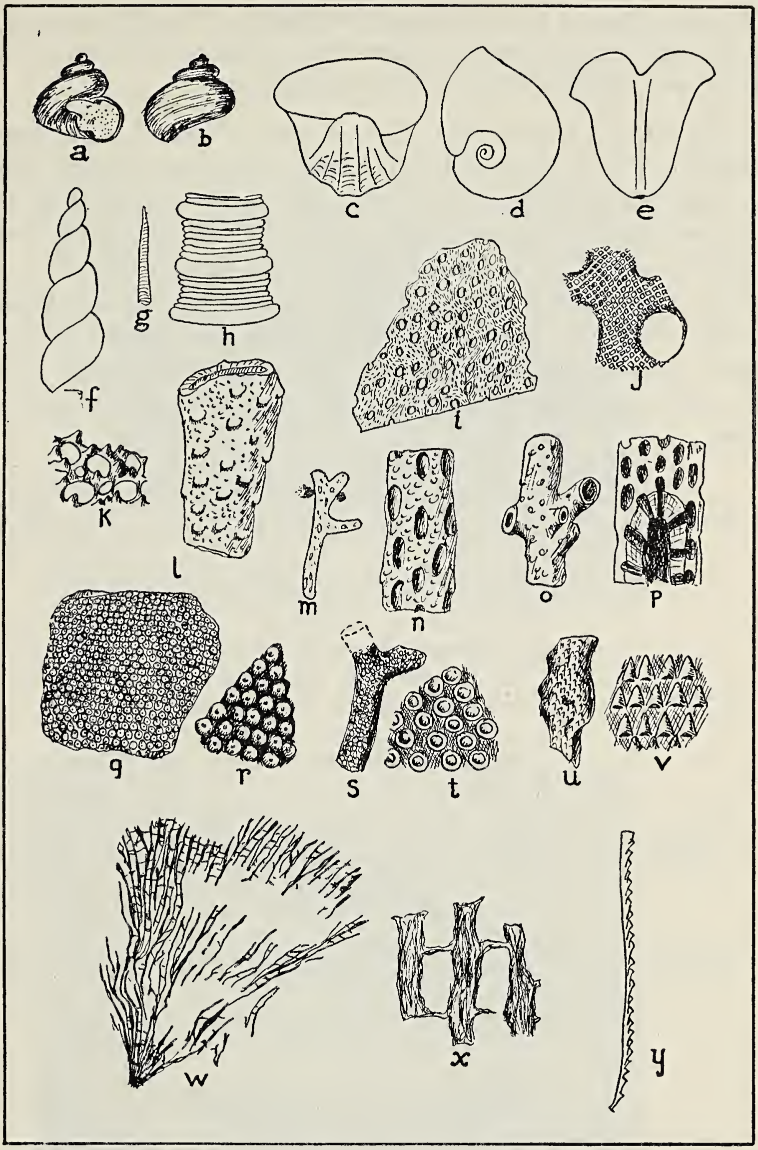


Figure 22 Upper Clinton fossils. (Gastropods, *a, b;* pteropod, *g, h;* bryozoans, *i-v;* graptolites, *w-y*). *a, b Strophostylus cancellatus. c, d, e Bucania bellerophon. f Hormotoma subulata. g, h Tentaculites niagarensis* with enlargement. x 5. *i, j Clathropora frondosa* with enlargement, x 5. *k, l Lioclema asperum* with enlargement, x 5. *m, n Acanthoclema asperum* with enlargement, x 5. *o, p Eridotrypa solida* with enlargement, x 5. *q, r Rhinopora verrucosa,* with enlargement, x 5. *s, t Stictotrypa punctipora* with enlargement, x 5. *u, v Fistulipora crustula* with enlargement, x 5. *w, x Dictyonema sculariforme* with enlargement, x 5. *y Monograptus clintonensis.*

those who desire a more thorough knowledge of the life of the Clinton the following measured sections from College hill, Dawes Creek quarry and Willowvale have been introduced.

College Hill Creek section. This section is located along Rogers creek, the first stream north of College street and College hill in the township of Kirkland. It was measured by a hand level from the point where the stream passes under Bristol road to the north-south road which passes through the Vernon on the west.

The section includes parts of the Clinton, Lockport and Vernon. Of the Clinton only parts of the Willowvale and Herkimer are exposed, 120 feet in all; of the Lockport, 48 feet are found; and as the section extended only to the road, only 60 feet of the Vernon is seen.

		Feet
Vernon	Red massive shale, green spots occasionally	260–320
	Green fissile shale, well laminated	256.0
	Covered	0.0
Lockport	Dark gray calcareous fissile shale with stromatoporoid reef and casts of channel marks	228.0
	Dark blue shale with stromatoporoid reef, and geodic zones with calcite, sphalerite	200.8
	Dark gray dolomitic shale, stromatoporoid reef and interformational conglomerate (edgewise conglomerate) near contact with Clinton below	188.8
Clinton: Herkimer	Sandy shales and dolomite lentils	180.0
	Massive hematitic dolomite (4 feet thick)	140.0
	Hematitic sandstone (16 inches thick)	120.0
	Sandy shales and dolomite	85.0
Willowvale	Hematitic dolomite	70.0
	Suboölitic hematite and red flux zone	60.0
	Covered	51.2
	Horizon of oölitic hematite, south of Norton Mine	0.0
	Bristol road	0.0

So much of this section is covered that it is impossible to estimate the exact thicknesses of the formations or their subdivisions but it serves a triple purpose of giving us the superposition, the types of rocks within the formation and the approximate thicknesses. The first 20 or 30 feet is undoubtedly of Sauquoit age, while 18 feet of the lowermost exposed Clinton is probably Willowvale with its suboölitic zone which is one of the most persistent members in the region.

Figure 23 Cast of channel marks from the Middle Clinton (Upper Sauquoit). (Photograph by V. Caldwell)

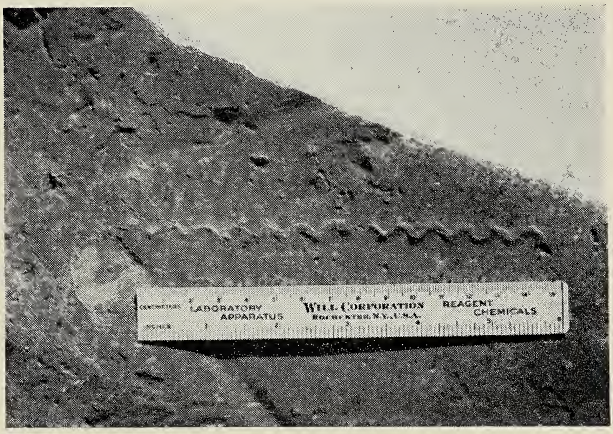


Figure 24 Trail of gastropod or worm from the Herkimer. (Photograph by V. Caldwell)

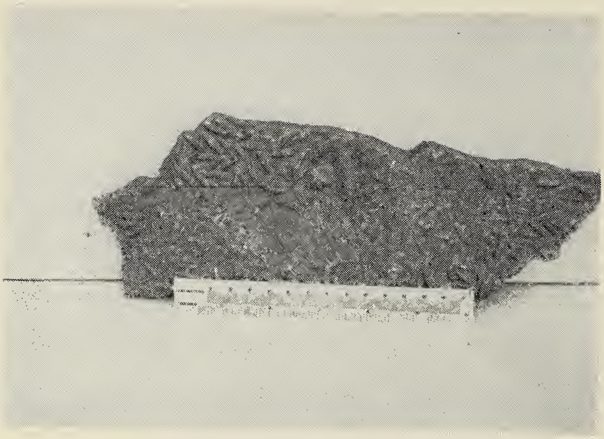


Figure 25 Seaweed stems or worm track? Herkimer sandstone. (Photograph by V. Caldwell)

Figure 26 *Palaeocyclus rotuloides* from Upper Clinton (Willowvale). (Photograph by V. Caldwell)

The College Hill Creek exposure is poor because so much of the course is covered by debris and because the stream is interrupted by artificial dams. This section, measured by Tracy Gillette (1940) with a transit, is as follows:

Salina

90 feet
Vernon red shale. Some green shale near the base. Outcrops at bridge over College Hill creek and continues downstream 955 feet.

Lockport

63 feet
Lockport dolomite. Some shale layers. Dolomite layers often with curved irregular surfaces. Highest layer outcrops 955 feet east of road; lowest 1960 feet east of bridge.

Upper Clinton

87 feet 6 inches
Calcareous sandstone. Character extremely variable: in the lower part of the section, gray and brown arkosic sandstones; 20 feet from the top, a 3-foot layer of red sandstone. Limestone layers present, but usually sandy; gray sandy shale layers present. Most of the fossils found in the shaly and limy layers. Highest layer outcrops 1960 feet below the bridge; lowest found in contact with the red flux 3675 feet from bridge.

Graptolites
Dictyonema retiforme (Hall)
Bryozoans
Mesotrypa nummiformis (Hall)
Clathropora frondosa Hall
Rhinopora verrucosa Hall
Fistulipora crustula Bassler
Lioclema asperum (Hall)
Stictotrypa punctipora (Hall)
Acanthoclema asperum (Hall)
Eridotrypa solida (Hall)
Brachiopods
Lingula perovata (Hall)
Leptaena rhomboidalis (Wilckens)
Atrypa reticularis (Linnaeus)
Whitfieldella nitida (Hall)
Pentamerus ovalis Hall
Dalmanella elegantula (Dalman)
Stropheodonta profunda (Hall)
Schuchertella subplana (Conrad)
S. tenuis (Hall)
Cephalopods
Dawsonoceras annulatum (Sowerby)
Trilobites
Dalmanites limulurus (Green)
Homalonotus delphinocephalus Green

4 feet 7 inches
Red hematitic sandy limestone commonly called "red flux." Upper part contains quartz in abundance. Shale partings found in the limestone. Hematite not equally distributed but more plentiful in a 2-foot layer near the middle. Layers with very little hematite often contain pyrite; siderite also found. Fossils often composed of siderite; some show siderite in the center and hematite on the outside. With the exception of bryozoans, fossils few.

Bryozoans
Fenestella elegans Hall
Cladopora fibrosa Hall
Eridotrypa solida (Hall)
Acanthoclema asperum (Hall)
Brachiopods
Schuchertella subplana (Conrad)

Dawes Quarry Creek section, town of Kirkland. This section, an excellent outcrop of the Upper Clinton, is located east of the main part of the village of Clinton on a creek which is crossed by a north-south road. The road forms the second three corners east of Clinton village on the Clinton-Willowvale road. Rock outcrops on both sides of the bridge over that stream. The section was measured with a transit.

Upper Clinton

78 feet Gray sandstone with green sandy shale layers; some layers calcareous. Upper 6 feet contains sandy and dolomitic layers with many crinoid stems. Lower 14 feet a thin-bedded white sandstone. This part of the section more fossiliferous than any other. Highest layer outcrops 160 feet east of the bridge; lowest 760 feet west or down stream from the bridge.	Plants *Rusophycus biloba* (Vanuxem) *Buthotrephis palmata* Hall *B. gracilis* Hall Bryozoans *Fenestella elegans* Hall *Callopora elegantula* Hall Brachiopods *Rhynchonella plicatella* (Linnaeus) *Rhynchotreta cuneata* (Hall) *Pentamerus ovalis* Hall *Dalmanella elegantula* (Dalman) *Rafinesquina obscura* Hall *Strophonema orthididea* (Hall) *Stropheodonta profunda* (Hall) *Schuchertella subplana* (Conrad) *Leptaena rhomboidalis* (Wilckens) Pelecypods *Pterinea emacerata* (Conrad) *Cuneamya alveata* Whitfield & Hovey *Ctenodonta elliptica* (Hall) *Modiolopsis subcarinatus* Hall *M. ovata* Hall *Leptodesma rhomboidea* (Hall) Gastropods *Strophostylus cancellatus* (Hall) Cephalopods *Dawsonoceras annulatum* (Sowerby) Pteropods *Tentaculites niagarensis* Hall Trilobites *Calymene niagarensis* Hall *Dalmanites limulurus* (Green) *Homalonotus delphinocephalus* (Green) Ostracods *Beyrichia veronica* *Dizygopleura proutyi* Ulrich & Bassler *Paraechmina postica* Ulrich & Bassler *P. spinosa* (Hall)
2 feet 8 inches Red hematitic limestone. Commonly called red flux. Lowest layer outcrops 780 feet below the bridge. Limestone once quarried for flux; quarrying carried on to the south of the stream bed.	Bryozoans *Cladopora fibrosa* Hall *Fenestella elegans* Hall *Callopora elegantula* Hall *Eridotrypa solida* (Hall) *Acanthoclema asperum* (Hall) Brachiopods *Schuchertella subplana* (Conrad)
10 feet 7 inches Gray massive sandstone. Upper 2 feet 6 inches contains some calcite and hematite; upper part also contains pyrite and siderite. No fossils found. Lowest layer outcrops 960 feet west of the bridge.	

18 feet 4 **inches**
Green shale with calcareous layers. Below massive sandstone already described, no outcrops in the stream bed, but the stream turns north just below the falls formed by the sandstone. On east side of the valley 1450 feet below the bridge is Old Franklin Iron Ore Mine. Iron worked by open cut until overburden became too great, then underground methods employed. In this way the shale directly overlying the oölitic ore is exposed. Due to the fact that ore has not been taken from this mine for many years the rock is badly weathered. Fossils listed not only those from the Franklin mine, but also those collected from same green shale in other mines and on dumps outside the mines.

Graptolites
Dictyonema retiforme (Hall)
D. gracilis (Hall)
Retiolites venosus Hall
Monograptus clintonensis (Hall)
Corals
Paleocyclus rotuloides (Hall)
Brachiopods
Chonetes cornutus (Hall)
Dalmanella elegantula (Dalman)
Atrypa reticularis (Linnaeus)
Plectambonites transversalis Wahlenberg
Camarotoechia acinus (Hall)
Leptaena rhomboidalis (Wilckens)
Spirifer radiatus (Sowerby)
Schuchertella subplana (Conrad)
Lingula lamellata Hall
Coelospira sulcata Prouty
Cyrtia meta (Hall)
Scenidium pyramidale Hall
Pholidops squamiformis (Hall)
Pelecypods
Pterinea emacerata (Conrad)
Leptodesma rhomboidea (Hall)
Ctenodonta mactriformis (Hall)
Gastropods
Cyclonema varicosum Hall
Cephalopods
Dawsonoceras annulatum (Sowerby)
Orthoceras bassleri Prouty
Trilobites
Liocalymene clintoni Vanuxem
Calymene cresapensis Prouty
Dalmanites limulurus (Green)
Ostracods
Beyrichia lakemontensis var. *borsti* Gillette
Dibolbina clintoni Gillette
Mastigobolbina typus Ulrich & Bassler
M. punctata Ulrich & Bassler
M. trilobata Ulrich & Bassler

2 feet
Oölitic iron ore. No mine working in the summer of 1935 but ore worked two months of the year for paint.

Willowvale section, town of New Hartford. A very good section is exposed by the creek which flows east into Sauquoit creek at Willowvale. The rock is found in the stream bed and in cliffs along the streams. Three artificial lakes cover some rock, but by studying both the stream bed and cliffs nearly a complete section can be obtained. The area of outcrop was once used as a picnic ground, known in the past as Roger's glen. Section measured and checked with transit, according to Tracy Gillette.

Upper Clinton

41 feet 6 inches Gray sandstone. Lowest layers slightly calcareous; some sandy layers. Very few fossils. This part of the section found above second artificial lake and in banks above the natural falls. A cliff above the falls and 2490 feet west of main street in Willowvale, exposed whole section.	Plants *Rusophycus biloba* (Vanuxem) Brachiopods *Rhynchonella plicatella* (Linnaeus) *Rhynchotreta cuneata* (Hall) *Pentamerus ovalis* Hall *Rafinesquina obscura* Hall *Stropheodonta profunda* (Hall) *Schuchertella subplana* (Conrad) Pelecypods *Mytilarca mytiliformis* (Hall) *Modiolopsis subcarinatus* Hall *M. ovata* Hall Cephalopods *Orthoceras clavatum* Hall *Dawsonoceras annulatum* (Sowerby) Trilobites *Homalonotus delphinocephalus* (Green) Ostracods *Dizygopleura proutyi* Ulrich & Bassler
4 feet 2 inches Red hematitic limestone, so-called "red flux." Besides hematite contains pyrite and siderite. Fossils plentiful but number of individual species small; not dwarf. Limestone forms cap rock of falls above second lake.	Bryozoans *Cladopora fibrosa* Hall *Fenestella elegans* Hall *Callopora elegantula* Hall *Acanthoclema asperum* (Hall) *Eridotrypa solida* (Hall) *Stictotrypa punctipora* (Hall) Brachiopods *Rafinesquina obscura* Hall *Schuchertella subplana* (Conrad) *Stropheodonta profunda* (Hall) *Leptaena rhomboidalis* (Wilckens) *Atrypa reticularis* (Linnaeus) Trilobites *Dalmanites limulurus* (Green) *Homalonotus delphinocephalus* (Green)
2 feet 10 inches Bluish gray limy shale. Although fossils of this shale resemble ones found in the underlying shale, lithology different; more calcite present. Shale crumbles rather than breaks parallel to any bedding plane. Fossils abundant, but poorly preserved; many broken. Whole bed may represent reworking of lower shale; upper layer appears to be shell rubble. Contact with overlying limestone wavy. Found immediately below cap rock of the falls, already described and located.	Bryozoans *Mesotrypa nummiformis* (Hall) Brachiopods *Atrypa reticularis* (Linnaeus) *Leptaena rhomboidalis* (Wilckens) *Dalmanella elegantula* (Dalman) *Whitfieldella intermedia* (Hall) *Plectambonites transversalis* Wahlenberg *Schuchertella subplana* (Conrad) *Chonetes cornutus* (Hall) *Coelospira sulcata* Prouty *Nucleospira pisiformis* Hall *Spirifer radiatus* (Sowerby) *Camarotoechia neglecta* (Hall) Pelecypods *Pyrenomoeus cuneatus* Hall *Pterinea emacerata* (Conrad) *Ctenodonta machaeriformis* Hall

	Gastropods *Cyclonema varicosum* Hall *Strophostylus cancellatus* (Hall) Cephalopods *Dawsonoceras annulatum* (Sowerby) Trilobites *Dalmanites limulurus* (Green) *Liocalymene clintoni* Vanuxem Ostracods *Mastigobolbina typus* Ulrich & Bassler *M. trilobata* Ulrich & Bassler *M. punctata* Ulrich & Bassler *Plethobolbina typicalis* Ulrich & Bassler
18 feet 3 inches Greenish gray shale with few thin limestone layers especiallv near base. Although not a truly fissile shale, rock thin-bedded and splits parallel to bedding planes. Highest layer found outcropping under above described shale in the rock forming the falls; lowest layer outcrops 20 feet down-stream from dam forming second lake. Outcrop 2025 feet west of main street of Willowvale.	Graptolites *Dictyonema retiforme* (Hall) *D. gracile* (Hall) *Monograptus clintonensis* (Hall) *Retiolites venosus* Hall Corals *Chaetetes lycoperdon* Hall *Paleocyclus rotuloides* (Hall) Bryozoans *Ceramopora imbricata* Hall *Fenestella elegans* Hall *Acanthoclema asperum* (Hall) *Rhinopora verrucosa* Hall *Eridotrypa striata* (Hall) *Semicoscinium tenuiceps* (Hall) Brachiopods *Nucleospira pisiformis* Hall *Coelospira sulcata* Prouty *Dalmanella elegantula* (Dalman) *Leptaena rhomboidalis* (Wilckens) *Plectambonites transversalis* Wahlenberg *Chonetes cornutus* (Hall) *Bilobites bilobus* (Linnaeus) *Atrypa reticularis* (Linnaeus) *A. nodostriata* Hall *Camarotoechia neglecta* (Hall) *Schuchertella elegans* Proutv *S. tenuis* (Hall) *Schuchertella subplana* (Conrad) *Strophonella patenta* (Hall) *Rhynchonella bidens* Hall *Spirifer radiatus* (Sowerby) Pelecypods *Pterinea emacerata* (Conrad) *Pyrenomoens cuneatus* Hall *Cuneamya alveata* Whitfield & Hovev *Leptodesma rhomboidea* (Hall) *Ctenodonta machaeriformis* Hall Gastropods *Cyclonema varicosum* Hall *Hormotoma subulata* (Conrad) Cephalopods *Dawsonoceras annulatum* (Sowerby) *Orthoceras bassleri* Prouty

Trilobites

Liocalymene clintoni Vanuxem
Dalmanites limulurus (Green)

Ostracods

Beyrichia lakemontensis var. *borsti* Gillette
Mastigobolbina typus Ulrich & Bassler
M. trilobata Ulrich & Bassler
M. punctata Ulrich & Bassler
Plethobolbina typicalis Ulrich & Bassler

6 feet

Missing. This part of the section is covered and the topography is such that it can not be uncovered without an enormous amount of work. Pieces of oölitic ore were found in the stream and along the steep banks, but its exact location could not be determined. This covered area is found at the dam which forms the second lake.

Middle Clinton or Sauquoit Beds

46 feet 4 inches

Greenish gray sandy shale also slightly calcareous. Abundance of sandstone layers, thin, usually not more than 2 inches thick. Ostracods are better preserved than in the underlying beds. Highest layers exposed at the foot of second dam; lowest layers outcrop in cliff below first lake and 1280 feet west of main street of Willowvale.

Corals

Chaetetes lycoperdon Hall

Brachiopods

Coelospira hemispherica (Sowerby)
Leptaena rhomboidalis (Wilckens)

Conularids

Conularia niagarensis Hall

Ostracods

Mastigobolbina lata (Hall)
M. clarkei Ulrich & Bassler
M. vanuxemi Ulrich & Bassler
Zygobolbina conradi Ulrich & Bassler

14 feet 9 inches

Green sandy fissile shale with few sandstone layers. In some layers ostracods very plentiful; in others fossils relatively scarce. As a whole ostracods poorly preserved. Highest layers seen in the stream bed above first lake; lowest layers best observed in high cliff at entrance to glen on south side of creek. The shale rests on conglomeratic layer with irregular top.

Brachiopods

Coelospira hemispherica (Sowerby)
Chonetes cornutus (Hall)

Pelecypods

Pterinea emacerata (Conrad)

Ostracods

Mastigobolbina lata (Hall)
M. lata var. *nana* Ulrich & Bassler
Zygobolbina conradi Ulrich & Bassler

50 feet 4 inches

Green sandy shale. Some layers calcareous. Many conglomeratic layers increasing toward base of shale; lenslike, so much so that they sometimes appear as boulders in the shale. Some conglomeratic layers extend length of outcrop with little change in thickness. In all observed cases tops unconformable. Shale layers very fossiliferous. Higher layers of conglomerate seen in the high cliff at the beginning of glen on south side of stream; lowest outcrop in stream bed 360 feet west of main street of Willowvale.

Brachiopods

Coelospira hemispherica (Sowerby)
Chonetes cornutus (Hall)
Leptaena rhomboidalis (Wilckens)

Pelecypods

Pterinea emacerata (Conrad)
Cyrtodonta alata (Hall)
Leptodesma rhomboides (Hall)
Amphicoelia orbiculoides (Grabau)
Ctenodonta machaeriformis Hall

Gastropods

Cyclonema varicosum Hall

Trilobites

Liocalymene clintoni Vanuxem
Dalmanites lumulurus (?) Green

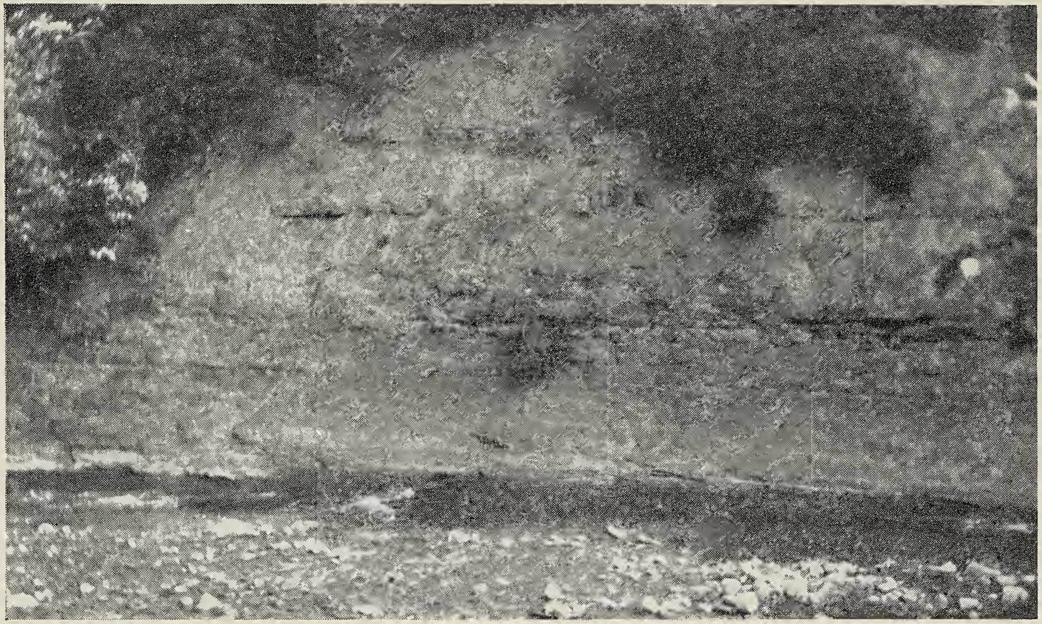


Figure 27 Niagara (Lockport) and Pittsford shales? at Farmers Mills. Heavy beds are stromatoporoid reefs. *Eusarcus vaningeni* was found above upper reef. (Photograph by N. C. Dale)

Ostracods
Mastigobolbina lata (Hall)
M. lata var. *nana* Ulrich & Bassler
M. vanuxemi Ulrich & Bassler
Zygobolbina conradi Ulrich & Bassler

Gillette's interpretation of the Dawes Quarry section is as follows (personal communication):

In the Dawes Quarry creek seven feet of sandstone is found directly overlying the Willowvale shale. (This sandstone is apparently a local lens and due to some local condition not apparent at the present time.) It could not be located at Willowvale. The Clinton is noted for its lenticular formations but to the best of my knowledge this is the only lenticular sandstone. It is probably of *Mastigobolbina typus* age, although no definite proof in the form of ostracods was discovered.

The Herkimer sandstone with the red flux at its base bears the same ostracods as the Rochester shale and is its shoreward equivalent. The Rochester can be traced through various stages into the Herkimer. This fact together with the similarity in ostracod fauna would seem to definitely correlate the two.

Vanuxem unquestionably placed the Herkimer in his original Clinton group. Since his work antedates Hall's, I have followed him [and also Ulrich] in placing the Herkimer in the Clinton group. One other strong reason for including the Herkimer in the Clinton is the fact that if anything is Clinton, it must be the Clinton iron ores. No one can justly separate the red flux from the Herkimer sandstone.

Lockport Dolomite

The only representative of the Niagaran limestone in east central New York appears to be the Lockport dolomite. It derives its name from its occurrence at Lockport, in Niagara county, but it is known to extend as far as Steele's creek in Herkimer county. This formation, in the west consisting of dolomite or magnesium limestones and resting upon the Rochester shale, is found in the Oriskany quadrangle to rest on the eastern shoreward representative of the shales, known as the Herkimer sandstone. Here, the Lockport measures between 59 and 87 feet, though only 59 feet are exposed in the writer's measured section in Roger's glen on College hill, and is made up primarily of dark gray carbonaceous shales, with intercalated argillaceous and silicious dolomitic algal reefs, with which there is involved considerable edgewise conglomerate.

Eusarcus vaningeni Clarke and Ruedemann and *Lingula cuneata* Conrad have been identified in the upper part of the formation at Farmers Mills but, so far, has not been identified elsewhere. It would appear that this upper part of the so-called Lockport may have some relationship with the base of the Salina, considering the eurypterid fauna. Except for a very conspicuous thin, shaly, seaweed bed found at the Farmers Mills section and the stromatoporoid reefs found at the Farmers Mills and the College Hill sections, the formation is quite barren of fossils (figure 27).

As the formation is made up largely of nonfossiliferous dark gray shales and dolomitic reefs and has no strata indicating deposition during a gradual lessening of marine conditions, some believe, because of the occurrence of dolomite within a few feet of the overlying Vernon, that these beds had not been losing their strictly marine character but that deposition had become more restricted, thus creating a transition zone between the more truly marine Clinton, and the more continental phase of the overlying Salinan.

Distribution in Oriskany area. The Lockport in the Oriskany area occurs as a relatively narrow band paralleling the contours on the inface slope of the cuesta and along the slopes of the Oriskany and Sauquoit valleys. Its greatest width of outcrop is seen north of Vernon Center, in the western part of the area, where the band is one and one-fourth miles wide, and along Dean's creek, but it narrows down to only one-sixteenth of a mile west of Chadwicks in the Sauquoit valley.

Farmers Mills (*Dugway*) *section.* Perhaps the best section of the Lockport is seen at Farmers Mills, or what is locally known as "The Dugway," where the Oriskany creek has cut a postglacial gorge through the Lockport, Pittsford and the overlying Vernon (figure 27). This section is exposed on the east bank of the Oriskany creek, approximately between the 620 and 660-foot contours (representing 35 feet), where it meets the overlying Vernon by a sharp contact. Conspicuous N. 50° E., N. 77° E., N. 23° W. and east-west joints cut the formation. The marked feature of this series is the reef character of the dolomite, as seen in two reefs in the lower part of the section, one of which appears as a series of continuous concentrically-banded concretions, which upon cross-section present a cuspidal curvelike form, measuring nine by 28 inches in diameter. It is believed that these reefs are the product of rock-making stromatoporoids interpreted as such because of their curious nodular surfaces, although no internal structures have so far been identified. This same reef shows to better advantage in the College Hill section.

An interesting feature of the reef is the mineralized character of certain geodic layers, which carry quartz, calcite, dolomite, pyrite and chalcopyrite, either disseminated or associated with the geodes. Generally the quartz crystals occur sparingly in the outermost or innermost parts of the geode, as doubly terminated crystals associated with calcite, although the calcite generally dominates and frequently completely fills the geode. No sphalerite has as yet been identified in the section. The more shaly zones of this section contain occasional dark carbonaceous dolomite, which becomes lighter toward the Vernon contact. Some of these are more or less lenticular in character, but have concretionary tendencies in the lower part of the section.

Only a few organic remains have been detected in this locality, such as eurypterids, lingulas and orbiculoideas, seaweeds and stromatoporoids. The late Professor Van Ingen of Princeton University discovered a loose block of a concretionary layer at the foot of the east cliff containing three carapaces and other parts of a eurypterid (*Eusarcus van ingeni* Clarke and Ruedemann) as well as lingulas and orbiculoideas (Clarke and Ruedemann, 1912, p. 420-25). The horizon from which this concretionary block is supposed to have fallen is 21 feet below the base of the red Vernon, or 14 feet below the base of the green Vernon, in the shale beds associated with the seaweed. Many hours of careful search have failed to reveal a duplicate of this block or any other eurypterid. Hartnagel has considered this formation at Farmers Mills as an equivalent of the Pittsford shale, the lowest formation of the Salina beds of New York, and it is possible that the upper part of the formation might very well be of Pittsford or Salinan age, and the lower part, containing the reefs, may belong to the Lockport, although no gradational lithology was observed between the Vernon and the shales of the underlying formation, the evidence resting entirely upon the eurypterid.

College Hill section. The writer has found 59 feet of Lockport exposed in the College Hill section. As in the Farmers Mills exposure, this section consists of dark carbonaceous shales and dolomite, the latter found principally in zones which are believed to be of stromatoporoid reef origin. The contact with the overlying Vernon is not visible; approximately 28 feet intervene between the exposures of the uppermost Lockport and the lowermost green shale member of the Vernon.

	Vernon, red massive shale. Vernon, green fissile shale member.
28.0 feet	Covered.
28.0 feet	Dark gray calcareous shale. Dolomite stromatoporoid reef, with irregular discoidal bodies with cuspidal cross-section, and nodular surface. Dark blue calcareous fissile shale, weathering a light gray, with dolomitized semi-cylindrical casts of channel marks along intersecting N. 5° W. and N. 35° W. directions.

	More compact calcareous and nonfissile shale, with paperlike shale below, and edgewise conglomerate, consisting of dome-like radiating masses with pebbles three and four inches long, all set in dolomite. A polished glacial boulder of this inter-formational conglomeratelike formation, measuring 10 x 8 x 3 inches, consists of a pell-mell mass of dark massive pebbles of impalpable texture varying in length from one to three and three-eighths inches, and in width up to one-half of an inch, all set in a dark gray dolomitic matrix (Pettijohn, 1926, p. 361). Dark pebbles appear to be largely organic, not phosphatic or carbonaceous limestone, as in the lowest reef.
12.0 feet	Stromatoporoid reef, with an anticlinal roll-like nodular body 4 x 10 feet, with a N. 60° E. trend. This apparent folding in the dolomite might very well be explained as a result of contractional forces following dolomitization.
10 feet 4 inches	Dark blue shale, with geodic dolomitic zones, containing quartz, calcite and sphalerite, although the two latter minerals are sometimes found disseminated throughout the dolomite. One especially fine crystal of sphalerite, now in the Hamilton College museum, was found in this zone years ago. The crystal, set in a small scalenohedron of calcite, measures 3 x 3½ x 2½ cm and the dominating faces are 111, 111, 110 and 311. The crystal is entirely too large for accurate goniometric measurement. Sometimes this mineralized area is associated with rather large calcite segregations in this ravine and in the Root glen to the south of College street. Galena was reported by Oren Root from these ravines but in recent years it has not been observed. In the Root glen small grains of chalcopyrite are found disseminated in the dolomite in the sphalerite zone.
8.8 feet	Stromatoporoid reef, found at the bottom of the Lockport, associated intimately and confusedly with edgewise conglomerate, the latter cutting off or separating parts of the reef. The reef is really in two parts, with two feet of shale intercalated, the upper part comprising a composite reef, with the interformational edgewise conglomerate made up largely of elongated pebbles of dark, carbonaceous limestone in a shale matrix. These conglomerates (Twenhofel, 1932, p. 216-17) "are developed by the breaking up of a partially consolidated bed, and the incorporation of the fragments in new strata nearly contemporaneous with the original beds. Strong waves tear up the partially consolidated materials which are later re-deposited in a new stratum." The stromatoporoid reef, measuring between eight and nine inches, consists largely of dolomite, with disseminated sphalerite associated with calcite, and underlying the reef are 15 inches of dark gray dolomitic shale, with dolomitic lentils. This initiates the sedimentation of the Lockport, because, below this, sedimentation is entirely different, although we do find dolomite with sphalerite in the topmost member, and underlying it we find dark green shales, with brachiopods, as the uppermost member of the Herkimer.

Mineralogy. In the section of the Lockport on College hill, as well as in the ravines to the north and to the south, the following minerals have been found: calcite, dolomite, quartz, sphalerite, chalcopyrite and galena, but no trace of celestite has been noticed here, although it has been described from the Lockport at Sherrill (Monahan, 1928, p. 70-71).

The sphalerite described above is found associated with the geodic dolomite in the reef zones. It occurs disseminated in certain parts of the dolomite, with or without calcite, and generally as anhedral grains. The large crystal described above and presented to the Hamilton College museum in 1853 by J. S. Baker came from a geodic area associated with scalenohedra of calcite.

Minute anhedral grains and small aggregations of chalcopyrite occur with or without calcite in the dolomite, and the geodic areas of the Lockport. Chalcopyrite is not as abundant as the sphalerite.

Genesis of the sphalerite and chalcopyrite. It is not difficult to account for the genesis of such minerals as calcite and quartz. Secretions from the soft sediments in the form of colloids of silica, and the bicarbonate of lime would, under diogenesis, result in the formation of these minerals along divisional planes or in geodic areas. It would appear that such minerals would naturally be precipitated from descending waters.

To account for the sphalerite and chalcopyrite in other ways than through the process of sedimentation appears to be out of the question, as no post-Silurian igneous activities are known in this part of central New York except the basic dikes at Syracuse. It would appear that the sphalerite and the chalcopyrite were deposited from solution at about the time these rocks were undergoing consolidation and later, because we find both the minerals occurring as disseminations with and without calcite, and within and without the geodic dolomitic member of the Lockport. Certainly the geodic zone must have been first leached of its more soluble contents, which brought about the cavernous condition of the rock; and such a condition could only have taken place after the rock was consolidated. As there is no evidence of substances carried by thermal waters and no primary silicate minerals in these deposits, it would appear from the mineral association that the sphalerite and chalcopyrite were products of shallow deposits at temperatures and pressures not very different from those prevailing at the surface. It has long been firmly established that such elements as zinc and copper were present in the form of silicates and sulphides in the older crystalline rocks from which the Paleozoic limestones and other sediments have been derived, and furthermore that certain meteoric waters from the Silurian of Kentucky furnished zinc, H_2S and Na_2S (Siebenthal, 1915, p. 67-81). According to this investigation, "The zinc was carried by sulphuretted salt waters and by alkaline earth carbonate waters, the latter usually containing H_2S or CO_2, or both." The zinc and lead, and in this case copper, also, existed as finely disseminated sulphides in the older Paleozoic limestone. Waters containing CO_2 decomposed the sulphides with the formation of bicarbonate and hydrogen sulphide. In the presence of CO_2, H_2S is an effective precipitating agent, but when the moving solutions become stagnant in places suitable for deposition, which this geodic layer would be, CO_2 would escape and the remaining H_2S would precipitate the metals as sulphides.

Vernon Shale

The Vernon shale of the Salinan was so named in 1903 by Clarke from its type locality at Vernon in Oneida county, a few miles to the west of the Oriskany quadrangle. Because of its dominantly red color on this quadrangle, in contrast to the more somber color of most of its associated formations in central New York, particularly the overlying salt-bearing Camillus, and the problem of its origin, it has long been one of the most interesting formations in central New York.

As seen at its type locality the Vernon is predominantly a purplish red crumbly shale with some grayish green layers, zones of green spots and occasional shaly dolomitic layers of no great thickness. Its crumbly nature is apparent, not only at the exposure, but also in freshly quarried rocks after the first rain, when it softens and breaks down into small fragments, a quality long known in the campus walks and drives at Hamilton College.

No contacts with the overlying Camillus or underlying Lockport formation are known in the area, but the covered intervals measure only five or ten feet. At the base of the Vernon is a five to ten-foot zone of green shale, which is less crumbly in nature than the red Vernon and possesses a greater fissility than the overlying beds. While the contact of the Vernon with the overlying Camillus is not exposed at present, during the construction of the lower and newer college reservoir it was located between the 1040 and 1060-foot contours, where the Vernon was in contact with a thin zone of silicious shales.

The only evidence of stratification noted in the Vernon is seen in the widely separated basal green shale member and a higher shaly dolomite stratum. Nothing within the red shale, outside of these strata, shows evidence of stratification; in other words, it appears to be almost massive, except for a rough lamination here and there. The zone of green spots referred to beyond is apparently stratiform.

The estimated thickness of the Vernon ranges from 160 feet in the Sauquoit valley to 340 feet in the Kirkland ravine, a tributary of the Oriskany, but the maximum thickness, 600 feet, is found at Vernon, to the west of this area. At its eastern limit, outside the quadrangle between Herkimer and Saltspringville, the formation thins to disappearance. In the west the formation is not seen beyond the Batavia and Buffalo region (Alling, 1928, p. 23). The maximum thickness of the Vernon in this area appears to be in the Kirkland ravine, just to the south of College street where are found 180 feet more than in the Sauquoit valley, a thickness much greater than in any other part of the quadrangle. According to Schafer (1926, p. 22) who called the author's attention to this feature of the Vernon, "the apparent increase in thickness coupled with the intense slickensiding, suggests that deformation has shifted the western part upward in such a manner that the movement is taken up in the minute fractures and thereby evenly distributed throughout. If one foot of upward movement were taken up in a linear distance of 50 feet, the whole 100 foot discrepancy can be accounted for in the length of the Kirkland Ravine section." If original, such a lenslike body could have been produced by deposition on an irregular surface or by inequalities in the depositing material; if deforming movements were responsible for it, we should expect some evidence of that fact, and such evidence is seen in the slickensided joint planes. Deformation in the form of a thrust within the formation might easily accomplish the apparent thickening of 180 feet. No evidence of this is found in the underlying or overlying formations; hence it would appear that whatever lateral movement has affected all the formations in this region must have been concentrated upon the Vernon alone because of its highly susceptible or incompetent nature.

Structure. The stratiform arrangement of the green spots in the Kirkland ravine has already been noted. The red Vernon is cut by a number of joint planes, some persistent, others discontinuous. Most of these are knifelike in their directness, while others are curved and many appear to be slickensided. In descending order of their persistency, their directions, are as follows: N. 55° to 60° E., N. 54° W. and N. 35° E. The joint planes dip vertically for the most part, although those directed N. 34° W. have a dip of 84 degrees to the northeast. The accompanying figure (figure 28) was sketched from an area along the north bank of Kirkland ravine, and shows the great variety in character of some of the representative joint planes. The grooving and slickensiding of many of the joint planes, especially in some of the eastern and southern quadrants, has led the author to believe that a movement originated in the northwest, because of the absence of slickensides on the planes dipping

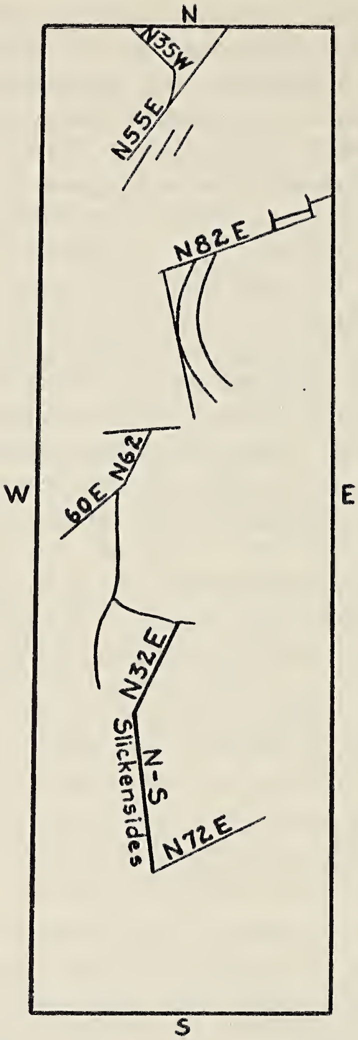


Figure 28 Jointing in a small section of Vernon along Kirkland ravine. Slickensides along N.S., N.65° W. striking and all N.E., S.E. and S.W. dipping joint planes.

northwest. The frequency of the joint planes and their curved character would suggest that some movement of a lateral or tangential nature had been applied to this region, and taken effect on one of the weakest of the formations. Such a deformation would affect the Vernon in the same manner that a thrust fault would; in other words, would cause a thickening of the formation at the point of rupture. As no actual fault plane has been so far discovered, such an explanation would account for the thickening of this Vernon formation from 160 feet in the Sauquoit valley to 340 feet in the Oriskany, a matter of six to eight miles. Alling (1941) believes these structural features of the Vernon are universal throughout much of the Vernon of New York. The upper and lower boundaries of the Vernon in the Sauquoit and Oriskany valleys are fairly definitely fixed.

Mineralogy and petrology. For the most part the Vernon shale appears to be an impalpable rock to the casual observer, although magnification and chemical analyses reveal the actual minerals in the rock. The following minerals are visible: amorphous hematite, siderite (or a ferruginous dolomite in scattered crystals) and some mica; quartz appears under the microscope. The following analyses, taken from Alling (1928, p. 46-50), and their recalculations, give us some idea of the mineral composition.

	RED SHALE		GREEN SHALE	
	*1	*2a	*3	*4
SiO_2	52.30	56.90	57.79	33.14
Al_2O_3	18.85	24.14	16.15	11.26
Fe_2O_3	6.55	6.26	5.20	2.31
FeO	....	1.26	....	1.06
CaO	3.36	.94	2.73	16.50
MgO	4.49	1.37	4.67	8.77
K_2O	4.65	3.69	4.11	2.56
Na_2O	1.35	1.00	1.22	1.21
CO_2	3.04	1.08	3.42	20.48
H_2O	5.30	4.36	4.50	2.88
	99.89	100.00	99.79	100.17

MINERAL RECALCULATION	RED SHALE		GREEN SHALE	
	*1	*2a	*3	*4
Quartz SiO_2	20.88	18.67	31.75	14.26
Sericite $KH_2Al_2(SiO_4)_3$	32.16	27.57	37.30	17.53
Paragonite $NaH_2Al_2(SiO_4)_3$	13.91	10.66	8.13	12.45
Chlorite $H_2Al_2(Mg,Fe)(SiO_4)_3 \cdot 3H_2O$	7.36	4.12	11.85	1.95
Epidote $Ca_2Al_2(AlOH)(SiO_4)_3$	8.28	1.75	2.91	5.74
Dolomite $(CaMg)CO_3$	6.18	2.58	7.32	43.10
Kaolinite $H_2Al_2(SiO_3)_2 \cdot 2H_2O$	8.81	28.06	....	....
Hematite Fe_2O_3	2.00	5.75	....	....
Water H_2O	.81	.35	....	1.08
Salt NaCl	....	....	.65	....
Gypsum $CaSO_4 \cdot 2H_2O$	Trace	Trace	Trace	Trace
	99.39	100.00	99.91	96.20

* 1 and 3 from Warners, Onondaga county, N. Y.
2a from Oneida Center, N. Y.
4 from Pittsford, Monroe county, N. Y.

The minerals composing the red Vernon in descending order of importance are as follows: sericite, quartz, paragonite, kaolinite, chlorite, epidote, dolomite, hematite and water; while the minerals of most importance in the green Vernon, as shown by recalculation, are dolomite, sericite, quartz, paragonite, chlorite, epidote and water also being found. Alling (1941, personal communication) suggests that "modern conceptions of the nature of the clay minerals would modify the nomenclature somewhat." It will be noted that the hematite in the red shale ranges from 2.0 to 5.75, while none is recorded for the green shale, although the Fe_2O_3 ranges from 2.31 to 5.20 and only 1.06 of the FeO is found. But the chlorite ranges from 1.95 to 11.85, and epidote from 2.91 to 5.74, so it would appear that the color of the green shale is probably due to the chlorite and epidote. It is remarkable that the average of the analyses for Fe_2O_3 in the green shale is 3.75, and in the red shale is 6.40. Since Alling has spent so much time in petrographic study of the Vernon it seems worthwhile to quote his views (1928, p. 95-96). He states that "the basal Vernon is not universally red." We have already noted that a ten-foot stratum of green shale appears to separate the red Vernon from the Lockport, or what Alling calls the black Vernon. Alling continues:

The mottled red and green beds . . . under the microscope consist of argillaceous matters, such as chlorite, epidote and sericite, with abundant quartz and the characteristic dolomitic rhombs. The eurypterid-bearing zones are more calcareous than the rest, indicating, if I have interpreted them correctly, detritus of rivers deposited in bodies of standing water, perhaps lagoons or euryhaline lakes. The pseudo-phenocrysts ranged from .008 to .01 mm in diameter, and hence come under the classification of rock flour. The groundmass is chloritic and sericitic. Quartz grains, small angular grains from .004 to .008 mm, never fail. The groundmass shows an arrangement that is characteristic of the Vernon. Around each rhomb of dolomitic calcite and quartz, sericite flakes are arranged in long shreds which give a much more angular appearance to the grains themselves. The chloritic matters are, as a rule, prevented from coming in contact with the pseudo-phenocrysts by these micaceous flakes. They give to the groundmass "a basket-weave pattern." . . .

In the mottled red and green layers the Vernon shows the same characteristic basket-weave pattern with fewer pseudo-phenocrysts of dolomitic calcite, but the quartz and occasionally feldspar and garnet grains are present. The red colorization is unquestionably secondary, probably derived from the chlorite. The iron content of the green and the red phases of the rock is very likely the same; the difference so noticeable to the eye is due to the state of the iron. In the form of chlorite the iron is principally in the ferrous condition, while the red color is due to ferric iron. The red hematitic matter is apparently amorphous and suggestive of colloidal iron oxide.[1] It obscures the other minerals when present as if a fine network of red matter had been interwoven into the basket weave fabric. In specially prepared slides, ground extra thin and with thin cover glasses, the oil-immersion lens picks out the basket-weave pattern even though masked by the iron oxide. Even in the reddest of the Vernon, this iron net-work is patchy; it is not uniformly distributed. In certain localities, such as at Oneida and Clinton, the Vernon is spotted with gray-green semispherical matters.

These green spots in the Clinton area occur in zones or stratiform areas one foot or less in width. Cross sections of these spots as seen on the steep banks in the bed of Kirkland Ravine brook appear to be circular as a rule, with diameters varying from the size of a pinhead to two and three inches, with and without dark centers, though these dark bodies or centers may be really eccentric. Frequently of pinhead size, these spots may exhibit concentric areas of lighter color, gradationally lighter from the center outwards. In this connection Miller (1910, p. 153-154) writes:

The spots range in size from a fraction of an inch to several inches in diameter. They are mostly spheroidal to flattened spheroidal, seldom irregular. When flattened along axes, they lie horizontal, thus suggesting that the flattening has been due to the pressure of the overlying strata, and this since the spots were formed.

[1] Alling (1941, personal communication) understands that colloidal substances were in the form of an hydroxide when deposited but an oxide at the present time.

The green spots are nearly always in sharp contrast with the surrounding red shale, but aside from color, there appears to be no difference in character between the red and the green materials. Although the spots are very irregularly arranged, they are, nevertheless, pretty uniformly distributed through the whole mass of red shale, and it is estimated that they make up less than 2 per cent of the mass. Another fact of importance is the frequent presence of dark to black centers in the green spots. Such dark centers, which are particularly well shown in Kirkland glen, range in diameter up to one-half of an inch, and they are rarely concentric. A much lighter shale commonly extends from the black center well out toward the periphery of the green spots. These dark centers are certainly organic, the dark color being completely removed by heating before the blowpipe.

Some of the green spots show protuberances, while others show greater divergences from the spheroidal shape, indicating that some spots are multiple or composite in nature, as though, having formed from several centers, they became one through development. The writer has not observed flattened spheroidal green spots, although such an occurrence would be expected if these green spots developed through the diagenetic process of the rock. When the spots are found in any considerable number, it is possible to note a local stratiform occurrence, rather than the pell-mell arrangement suggested by Miller; in other words, the zone in which they are found is essentially horizontal. Alling showed that the basket-weave pattern occurs in the green spots as well as in the red shale.

The cause of these green spots is not definitely known, although Miller argues for a change in the surrounding shale from the green to the red areas, whereas in the vicinity of the organic centers and surrounding green areas, the ferrous condition has not been changed to the ferric on account of the organic centers. In other words:

. . . the presence of the organic matter has simply prevented the appearance of the red color in the immediate radial vicinity of the organic center. Within the spots, then, the green color of the [green mineral which Miller believes to be] glauconite is allowed to come out, and it is this, rather than the small percentage of iron in the ferrous condition, which gives the green color. In each case, the size of the green spots has been directly dependent on the amount of decomposing organic matter. The presence of ferrous iron in both red and green shales may be readily explained, because this iron is probably mostly in the carbonate form, which would be pretty freely disseminated through the whole shale mass (*ref. cit.*).

If all the green spots had organic centers, or even pyrite, this deoxidizing influence would be the best explanation for their occurrence; but they are frequently without any visible organic centers, or pyrite, and according to the analyses there is no glauconite. It is possible that conditions within these spots prevented a change from ferrous to ferric iron, or the derivation of the iron from the chlorite, so that the coloration of these green spots is due entirely to the presence of chlorite and epidote. If, as has been suggested by Miller (1909, p. 154-55), the green spots contain ferrous carbonate, or a ferruginous dolomite, some sort of reduction process must have been responsible for them.

More uniformly disseminated reducing influences must have been responsible for the green strata at the base, top and within the central portion of the formation, because we find the iron and the chlorite in their ferrous condition. So far as the coloration of the red shale is concerned, as has been suggested by Alling, it must be secondary after chlorite, the iron occuring as finely divided pigmented hematite, this state of iron having been the product of moderate heat generated by the weight of the overlying beds.

Sedimentation. As noted above, the Vernon is predominantly a dark red massive shale, with occasional intercalated beds of green fissile shale and thin dark shaly dolomite. Near the top, but not seen in the Oriskany region, are scattered gypsum and anhydrite areas. As the Vernon underlies the Camillus, or the salt and gypsum-bearing formation of New York State, it has long been considered one of the continental deposits. Grabau believes (1913, p. 569) the Vernon to have been a loess deposit, the ultimate source of which was considered to have been the residual soil of the exposed Niagara limestone. Grabau says:

When we consider the former extent of the Niagaran strata from central New York to the Rocky Mountains and from the Ohio or westward to Hudson Bay, and its thickness, which in Wisconsin is still well over 800 feet, and realize that much of this was worn away during Salina time by the streams flowing into the Salina basins of the New York and Michigan, we can understand that the connate sea water held in these strata was quite sufficient to furnish all the salt of the Salina deposits. The intercalated limestone and shale layers likewise had their origin in the erosion products obtained from these Niagaran formations. The fact that all around the Salina area the upper Siluric strata rest on Niagaran except where the continental deposits of Salina time intervene and the further fact that no undoubted marine equivalents of the Salinan are known in North America, greatly strengthen the argument for the wholly continental origin of these salt deposits (*ref. cit.*, p. 379).

Alling's petrologic approach to the origin of the red and green Vernon is of course very logical. His conclusion is that the Vernon represents a delta silt deposit of a river flowing from a desert area into playa lakes or lagoons. The water-laid nature of the sand grains, the relatively low content of silica in the Vernon in comparison with that of loess, as well as the deficiency in alumina, ferric and ferrous oxides, and potash in the loess, would corroborate his conclusions. Loess appears to have been more sodic than potassic, or at least it contained as much soda as potash, a chemistry which is different from that of the Vernon, as shown by the analysis. The unconsolidated nature of the loess, and its vertical fracture, have little in common with the Vernon, although the ease with which the Vernon weathers would lead one to think that it had never been thoroughly consolidated. Alling (1928, p. 49) finds that the Vernon compares much more favorably with a river silt than a loess, so he believes that:

Emphasis can quite properly be placed upon analysis (11) as representing that of a delta of a river similar to those which it is believed existed during Salina times; a river draining a desert area. It would have been desirable to have tabulated the analyses of river silts flowing from such areas into saline waters but "analyses of river silts or muds are not very numerous, nor are they always comparable" (Clarke, 1916, p. 510).

The accompanying analyses (Alling, 1928, p. 50), although far from ideal, show very well that there may be something in Alling's conclusions:

MINERALS	NILE MUD	RED VERNON SHALE	
	11′	1′	2a′
Quartz	21.30	20.88	18.67
Sericite	15.35	32.16	27.07
Paragonite	9.46	13.91	10.66
Chlorite	16.80	7.36	4.12
Epidote and Uralite	23.05	8.28	1.75
Kaolinite	....	8.81	28.05
Hematite	3.42	2.00	5.75
Water	10.00	.81	.35
Gypsum	.77	Trace	Trace
Total	100.15	99.39	100.00

The important minerals, quartz, paragonite and hematite are fairly comparable, in the above analyses. In any case the Vernon appears to be a continental deposit, the source of which must have been some pre-existing land mass, presumably not far away from the old desert area.

From a structural standpoint there is very little to indicate that the Vernon was a loess or an old delta, although the more stratified members of the series would indicate shallow water origin. Alling's discussion of the origin of the Vernon (*ibid.,* p. 50-52) is very illuminating:

The geological reasons for believing that the Vernon is a river deposit are that the interbedded green shales, marlites and water-limes are without doubt marine formations which do not give the appearance of being deposited near the shore. Evidence is accumulating to the effect that the abrupt termination of the Vernon in eastern New York is caused by an overlap; the thinning of the formation is from the bottom up and not from the top down, and is due to overlap upon a previous land surface. Consequently there is but little data to be secured bearing upon the delta origin of the Vernon in the east. Our knowledge of the western margin is very incomplete. There are at least two interpretations of the change in color of the salina from red to gray, in passing from the Genesee Valley to Buffalo: (1) That the Vernon is overlapped by the Camillus. (2) That the red shales interfinger the gray shales by a gradational change.

It is believed that the theory that the Vernon is a river silt deposit would be in harmony with the latter interpretation.

If the Vernon is a river deposit the question arises regarding its correlations. In the Shawangunk conglomerate we possess a formation that may well be correlated chronologically as well as genetically with the Vernon. Grabau has already suggested a fluvial origin of this formation. It seems to me that the geologic age of the Shawangunk is still a matter of dispute. Schuchert (1916, p. 531-34) and Van Ingen (1911, p. 905) believe that it is of Medina age, while Grabau (1906, p. 123) and Hartnagel (1907, p. 50) are inclined to assign a Salina age to it. The presence of eurypterids in the Shawangunk has been proposed as evidence of its Pittsford age. But the presence of the genus Hughmilleria in both the Shawangunk and Schenectady beds (the latter of Ordovician age) makes questionable the value of eurypterids as index fossils. Schuchert bases his contention for the Medina age upon the finding of *Arthrophycus alleghaniensis* in the Shawangunk at Otisville. The value of "worm" trails and burrows as horizon markers is questionable. The Shawangunk, lithologically, may be of Oneida, Clinton (Herkimer) Vernon or Medina age, as far as our present knowledge is concerned. If, however, it is of Vernon age the hypothesis here suggested would be in accordance with the facts. Thus, the Vernon may represent the fine silts of the Shawangunk river, flowing northward into the area over which the later Camillus waterlimes and marlites were deposited.

Another possible correlation is, however, suggested: that the High Falls and the Longwood shales of southeastern New York and New Jersey are of Vernon age. These beds are red shales that may well be so related. Our present knowledge is too meager to permit a definite conclusion, yet there seems no adequate reason why the Vernon can not be a river silt deposit and perhaps correlated with the Shawangunk or the High Falls-Longwood beds.

It has already been shown that a completely satisfactory correlation between the lower Cayugan of New York and Maryland, upon paleontological grounds, is impossible. The close lithologic resemblance between the two series is certainly highly suggestive, as has already been pointed out.

There remains the method of investigating the climatic, physical and diastrophic evidence. Swartz points out that we possess excellent information for a tentative solution of this problem. In New York the Salina consists of the thick red Vernon, practically barren of fossils, overlain by the argillaceous, lime-mud rocks carrying salt and anhydrite which of course indicates arid conditions of sedimentation. The McKenzie-Bloomsburg-Wills Creek beds in Maryland suggest the same thing. In New York the red beds occur to a large extent, certainly on the outcrop, in the interval between the Lockport and the commercial beds of rock salt. In Maryland, in contrast, red beds appear only at the base of the Wills Creek, where the salt hopper crystals occur. In going eastward in Maryland, the red beds occupy a greater and greater thickness of the formation, until in the North Mountains they occupy a large part of the Wills Creek. East of this locality the rocks have been removed by erosion but judging from what is known, it is clear that it would not be necessary to go much farther before the entire formation was composed of red beds, overlying which the salt-bearing rocks would appear.

Swartz believes that "the open sea lay towards Maryland, where marine strata would occupy the same horizon as the red beds of New York. Due to oscillations of the sea the red deposits of the northeast would intertongue with the gray marine deposits in the southwest, with an increasing amount of marine formations toward the open sea. Marine fossils actually occur in ever increasing numbers to the southwest." More fossils are found in the beds of the same age in Maryland than in Pennsylvania, and more in the strata of Pennsylvania than is the case in New York. "Indeed, a change is manifest even in such narrow limits as are presented in the State of Maryland, marine forms appearing in ever increasing numbers toward the southeast, where arenaceous deposits give way to shale and then to limestone" (Swartz, 1923, p. 210).

Camillus Shale

Overlying the Vernon in the Cayugan series is the Camillus formation, so named from the type locality at Camillus in Onondaga county, where it includes, beside drab-colored fissile calcareous shales and flaggy dolomites, the lenses of gypsum and salt beds so abundant and so important to the west and south of Syracuse.

Though the maximum thickness of the Camillus of approximately 450 to 500 feet is found in Onondaga and Cayuga counties, in the central part of the belt in Oneida county and particularly on the Oriskany quadrangle, it ranges from 200 feet in the Sauquoit valley to 300 feet in the Augusta valley in the western part of the area.

The formation as studied here consists largely of drab-colored calcareous shales with flaggy dolomites, variegated and mottled reddish and yellowish green shales of saline nature. The green shales are for the most part sandy. Due to the facility with which parts of this formation weather, because of solution by carbonic acid, we find that darker colored rocks, such as the shaly and dolomitic members of the formation, assume drab or very light gray colors on the weathered surfaces. Certain zones of no great thickness in the drab shale members appear to have taken on a brecciated condition which was probably brought about through the effect of solution by ground water along the more soluble strata. Failure on the part of the undissolved rock to support itself results in separate fragments caving in, which later become cemented by calcite precipitated from circulating carbonated saturated waters. The prevalence of ground waters in this formation has been referred to earlier.

As contacts between formations are not abundant in this region, due largely to concealment by the drift, we could hardly expect to identify with certainty such as might exist between the Vernon and the Camillus. What appears to the author, however, as a possible contact is seen on the Clinton-Vernon Center road on the 990-foot contour, just beyond the England schoolhouse. The apparently lowermost member of the Camillus is a pyritiferous, sandy green shale and the uppermost member of the Vernon is characteristic red shale, the two contrasting members dovetailing into each other, as seen in cross section, and suggesting a gradational contact. No contacts with the overlying Bertie waterlime have so far been identified.

Since the drift-covered area overlying the Camillus has prevented exposures of complete sections, the following section is necessarily composite, made up largely of exposures occurring along the east slope of the Augusta valley through an apparent thickness of 140 feet:

Red shale
Mottled red and green shale
Light yellowish green sandy shale, with salt hopper casts
Drab-colored shales, with thin-banded dark gray dolomite, weathering light grav
Greenish and chocolate-colored sandy shale with rounded frosted sand grains
Drab-colored calcareous shales with thon-gallen, and dolomite lenses

Base .... Thin silicious shales

The predominant rock type is a drab-colored calcareous shale. One of the conspicuous shale members of the Camillus, namely, the mottled red and green shale from Augusta, of undetermined thickness, is predominantly a shale with zones or areas of conspicuous frosted subspherical sand grains measuring a millimeter or less in diameter. The mottling of the green shale with red, or vice versa, is of a very irregular nature, and so far as the red areas are concerned the shale owes its color largely to the fine granular hematitic pigment. So far as microscopic study can testify, it would appear that at least the red areas, if not the green, consist of reworked older areas of red and green shale, possibly of Vernon origin. Some pyrite grains altering to limonite are seen. On the whole this part of the Camillus is well-stratified, with certain areas laminated and finely clastic. Quartz is the most conspicuous mineral involved, albite is rare; there is more than 25 per cent dolomite in the green areas, and less than 10 per cent muscovite or sericite. The greater part of the shale is made up of the greenish matrix. Some 50 to 60 per cent of the greenish shale is characterized by kaolin and some form of ferrous iron while the red shale is a kaolin colored by ferric oxide.

Rock, such as just described, with its dominant red and green muds and frosted quartz grains and iron, could have been derived from a desert. These muds also could have been deposited in river flats near its mouth and then reworked, while undergoing deposition in lagoonal waters.

Alling reports (1928, p. 38) that in his petrographic studies of 30 slides of the Camillus only four failed to show carbonaceous matter. When it occurred, it took the form of ". . . long narrow ribbons, . . . 0.1 to 0.15 mm in length and 0.01 to 0.02 wide" or as "round pellets about .002 mm in diameter, frequently arranged in rows like beads strung on a string . . . . Carbonaceous matter of this kind is distributed throughout the Camillus . . . . It occurs in salt shales, above and below the mine horizons of the Retsof, Sterling, Greigsville and Livonia shafts; in the lime-mud rocks directly associated with the anhydrite taken from the mine shafts and in the gypsum bearing layers now worked for gypsum." So far the author has been unable to find any carbonaceous matter in the slides examined, although the pyrite found at the bottom of the Camillus might serve as indirect evidence of organic life.

From the results of the study of the constituent rock types of the Camillus, coupled with the scarcity of the fauna, it would appear to be obvious that the sediments comprising the Camillus must have been deposited in slowly subsiding shallow basins in an arid region not far from the sea. The presence of salt-hopper casts, gypsum and dolomite in this area and to a much greater extent in the western part of the State all testify to such an environment. Alling (1928) found that the only procedure in reconstructing the physiography and stratigraphy of the New York Salina was to review "conditions prevailing in adjacent states"; and so "some sort of a correlation between the Salina of Ohio, Ontario, Michigan, Pennsylvania and Maryland with that of New York was attempted." He found that:

> . . . the correlation of the Salina of New York with that of Ohio, Ontario and Michigan, together with that of the Wills Creek-Bloomsburg-McKenzie of Pennsylvania and Maryland, is a logical and reasonable one. Yet the Vernon and equivalent beds are probably peculiar to the New York-Pennsylvania-Maryland district. Under such a correlation two depositional basins are necessarily postulated. The Ontario-Michigan basin is probably the deeper of the two and lacks the argillaceous sediments known as the Vernon. The details of the evaporation and deposition of the salts differ in the two cases. In both basins, however, the salt is stratigraphically, petrographically and genetically associated with and related to the Camillus sediments of lime-muds (*ibid.,* p. 123).

We find this association of the hopper casts at Paris and Prospect hills to be the same as that found by Alling in connection with the main salt deposits. Although there are several slight differences within and between the correlated regions, for all purposes these basins were contemporaneous and contained approximately the same types of sediments. Alling continues:

> The Vernon appears, not as a loess deposit, but as river accumulated clays and fine argillaceous muds. The character of the Vernon suggests sluggish streams draining areas underlain by shales. On the outcrop the rock is red, but in depth to the south [in salt shafts] it is green and interbedded with gray and brown lime-mud rocks called dolomites. In Pennsylvania and in Maryland the red Vernon-Bloomsburg-McKenzie beds intertongue with drab impure limestones, and in western Maryland are not red but gray. The open sea appears to have been to the south of New York where we find marine sediments, with an ever increasing marine fauna in western Maryland. In eastern Maryland the beds equivalent to the Vernon are red, while in western Maryland they give way to the arenaceous beds which in turn give way first to shale and then to limestone. The arm of the ancient sea then crossed what is today western Maryland. In the northern extension of this depression, the New York Vernon was deposited.
>
> Over both the Michigan-Ontario and the New York-Ohio-Pennsylvania basins, the Camillus lime-muds were deposited in shallow lagoons; extensive playa lakes with occasional influx of sea water to which lime-muds were added by streams draining areas of eroding limestone (*ibid.,* p. 124).

New fossils for the Oriskany area and central New York are a Chondrites type of sea weed, *Halysites catenularia (Linnaeus)* a marine coral, a *rhynchonellid* type of brachiopod *(Camartoechia?)*, an unidentified gastropod and the ostracod, *Leperditia alta.* The only other fossil reported from the Camillus of central New York according to Ruedemann was *Ctenodonta saliensis* Rued. which was recognized at Bulls quarry, Lenox, Madison county and Bell Isle, Onondaga county.

Bertie Waterlime

Aside from the Manlius group of the upper Silurian, waterlimes and limestones found elsewhere in New York State: the Bertie waterlime, Cobleskill limestone and Rondout waterlime, the Bertie appears to be the only one exposed on this quadrangle although we do find mud-cracked waterlimes resembling the Rondout in the stone fences at the base of Prospect hill. The Bertie takes its name from the type section at Bertie in Canada, about six miles west of Buffalo. The best exposures in our area are found on Prospect hill and Crow hill. There are also several exposures on the flanks of the Oriskany hills northeast and northwest of Deansboro.

The Prospect Hill quarries. Of the two quarries near the northwest base of Prospect hill, the one west of the road is known as the Root quarry, the other, to the east, as the Town quarry. In each of these the rocks are presumably Bertie, consisting of flaggy beds of drab-colored, argillaceous dolomites. In the Root quarry minute solution pits and ostracods *(Leperditia alta)* are found, while in the Town quarry the only fossil that has ever been collected is *Eurypterus remipes.* The exposure here measures approximately 20 feet in thickness. Since the slopes of Prospect hill above this quarry are drift covered, it is not possible to determine the total thickness of the Bertie, to observe the contact between the Bertie and the Manlius or between the Bertie and the underlying Camillus, or to ascertain whether there is any Rondout present.

Crow Hill quarry. On the north slope of Crow hill, on J. Pierpont White's property, just south of the Clinton-Sauquoit road, is a road-metal quarry with a good exposure of the Bertie waterlime (figure 29). The section shown here includes the following:

Thin, flaggy dolomite (Rondout ?)	7 feet
Drab-colored argillaceous limestone beds, with eurypterid zone (fragments)	16 feet
Thin, flaggy beds of argillaceous dolomitic waterlime	6 feet

The middle 16-foot section shows many fragments of eurypterids. One specimen, measuring 13 cm in length, consists of 11 segments

Figure 29 Bertie waterlime locality where fragments of *Eurypterus remipes* are found. Crow hill. (Photograph by N. C. Dale)

and the telson. The town quarry on Prospect hill, however, has furnished the best specimen of *Eurypterus remipes* which Hamilton College students have found. This specimen shows a cephalothorax measuring 3.6 cm by 2.5 cm and three thoracic segments of the preabdomen.

Conditions of sedimentation. The presence of eurypterids and ostracods, as well as the abundance of mud cracks in the upper part, would indicate that the waters were in all probability shallow. Ostracods usually prefer the muddy bottom or the surface of shallow water. For further discussion of sedimentation the reader should consult Alling (1928, p. 53-55). Ruedemann believes that while the Bertie waterlime (1925, p. 11, 12) does not actually contain a typical marine fauna, the scarcity of forms may be due to "early and complete dissolution of the aragonitic shells in the dolomitic mud." The character of the fauna, with its number of strange forms and the relation of the waterlime to the western continuation of the Cobleskill limestone or the coral facies, and the close connection between the Bertie waterlime and this suggest that the Bertie was deposited in a lagoon behind coral reefs and that a sinking of the land resulted in an invasion of the sea, and a return of marine conditions in waters in which the barren Camillus was deposited (*ref. cit.*, p. 13). It would appear, from the presence of very few fossils here, that purely marine conditions could be found only to the southeast in Schoharie county where the Cobleskill appears.

Manlius Group

Several good exposures of members of this group (figure 30) on Prospect hill, the hills to the south of Prospect and Paris hill have given opportunity for study. No contacts with the underlying formation are visible and at the Paris hill exposure a small break in the limestone series would seem to indicate a disconformity between the Manlius and the overlying Coeymans. The Manlius limestones are found to cap most of the high areas in this region, both east and west of the Oriskany valley.

Burnett Smith's classification (1929, p. 27-32) of the Manlius will be followed in this study. So far as can be ascertained, the only members of the Manlius present in the area are the Olney and Jamesville limestones. In the Syracuse and Skaneateles areas (*ref. cit.*, p. 14), the Manlius is divided into the following members in descending order: Jamesville limestone, Clark Reservation limestone, Elmwood waterlime, Olney limestone.

Although Vanuxem (1842, p. 272-73) did not give names to the present various members of the Manlius group, he must have included the Jamesville and the Olney in his Manlius. In correlating the Manlius of the west with that of this area, it was found that in the Prospect Hill area and that to the south both the Olney and the Jamesville limestones are represented, the former exposed on the north slope of Prospect hill and in the Eisler quarry to the southwest. In the Prospect hill locality the ribbon limestone member of the Olney with its alternating blue and drab layers predominates, while in the Eisler quarry, where there is a 20-foot section, there are four feet of heavy-bedded, blue limestone overlain by a foot of fossiliferous plicated shaly limestone, which in turn is overlain by 14 feet of dark blue impalpable phosphatic limestone, ribbon limestone, and fossiliferous shaly partings. Overlying the quarry section are 15 to 20 feet of coarse gray-blue crystalline limestone, with abundant crinoidal columnals and sections, which we have included in the Jamesville. The division between the Coeymans and the Silurian is perhaps emphasized by the slight disconformity (?) indicated by a brecciated and interformational conglomerate zone between these two limestones in the Cittadino quarry at Paris hill. According to Ruedemann, the stromatoporoid reefs, corals, mud cracks and ripple marks all testify to a lagoon or tide flat facies of sedimentation during Manlius time. It seems best to describe the important exposures of the Manlius in this area, shown in Prospect hill, in the Eisler, Kirkland and Lawless quarries to the south and in the Cittadino quarry on Paris hill.

Prospect Hill section. The Olney member of the Manlius is best exposed in a partially concealed 15-foot section on the north side of the hill. Much of the upper part of the section is exposed in several pits on the summit of the hill where the limestone was formerly burnt for lime. The lower part of the section appears to consist of a typical ribboned limestone, mottled blue and drab in color from the weathering of the less pure calcareous and more argillaceous parts. It is a thin-bedded wholly fossiliferous limestone, the most common fossils appearing to be: the ostracod *Lepeditia alta* (Conrad), the gastropod *Loxonema fitchi* Hall, the brachiopod *Schuchertella interstriata* (Hall) and the coral *Favosites proximus*.

Between the base of the quarry on Prospect hill and the top of the underlying waterlimes, a thickness of 20 to 30 feet, there are no exposures.

Kirkland quarry. This quarry, situated about one and one-fourth miles south of Prospect hill, once supplied the flux for the pig iron made by the Franklin Iron Works from the Clinton hematite ores in the Franklin Springs furnaces in the latter part of the

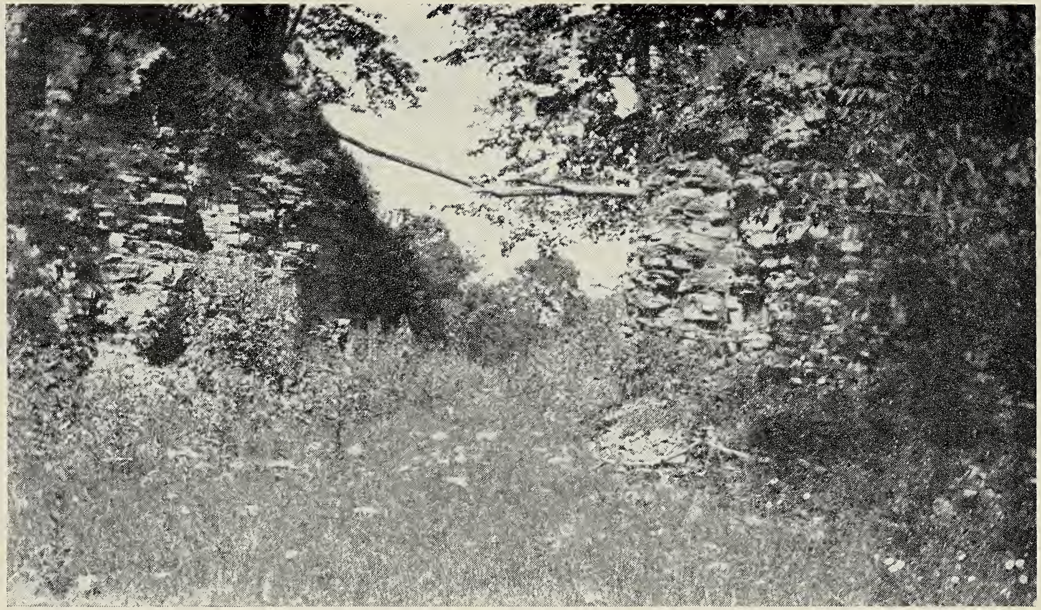


Figure 30 Entrance to Kirkland quarry showing Manlius limestone. Source of flux for furnaces at Franklin Springs. (Photograph by N. C. Dale)

nineteenth century. It is a lower Manlius exposure, consisting almost entirely of Olney limestone. The quarry measures 180 feet by 170 feet by 32½ feet (the face) and except for a wagon entrance through its walls on the east, it is entirely inclosed (figure 30). The actual thickness of the limestone here is about 32½ feet, and it consists largely of heavy, well-stratified dark blue limestone at the base, which, when struck with a hammer, releases a fetid odor. In the middle of the section is an impalpable dark blue limestone, weathering a light gray, with fossiliferous shaly partings, the brachiopods *Spirifer vanuxemi* (Hall) and *Stropheodonta varistriata* (Conrad) being quite common. Also on the exposed bedding surfaces, in addition to fragments of brachiopods, abundant crinoid parts were found and the pteropod *Tentaculites gyracanthus* (Eaton) Hall. Most of the brachiopods are restricted to the lower ten feet of the section, while the upper part consists essentially of crystalline limestone with *Stromatoporo (Syringostroma) barretti* Girty, some specimens of which measure as much as 12 cm by 17 cm. Occasionally the concentric bands of these stromatoporoids are replaced by flint. *Buthothrepis gracilis* (Hall), *Favosites sp.* and *Leperditia alta* (Conrad) also occur.

Eisler quarries. The two quarries belonging to the Eisler farm, mainly in the Manlius, are on opposite sides of the Prospect Hill road, a little over one and one-half miles south of Prospect hill, and something over seven-eighths of a mile southwest of the Kirkland quarry. The quarry nearest the road consists of a series of massive dark shaly carbonaceous limestones, and massive blue limestone beds, but attention should be directed to the quarry west of the road, consisting essentially of the Olney and Jamesville members of the Manlius. The section, from bottom to top, is as follows:

Jamesville	15 to 20 feet	Coarse granular blue crystalline limestone
Olney	14 feet	Ribbon limestone, with shaly partings. Dark blue impalpable limestone with phosphatic pebbles
	6 feet	Dark blue weathered limestone
	1 foot	Plicated shaly dark colored limestone, fossiliferous
	4 feet	Heavy-bedded dark blue limestone

A characteristic Manlius fauna consists of:

Plants

Buthothrepis gracilis (Hall)

Hydrocorallines

Stromatopora (*Syringostroma*) *barretti* Girty

Bryozoans
Monotrypella arbuscula (Hall)

Brachiopods
Spirifer vanuxemi (Hall)
Stropheodonta varistriata (Conrad)
Meristella laevis (Vanuxem)

Crinoids
Columnals and sections

Gastropods
Phanerotinus laxus Hall

Worms
Serpulites sp.

Lawless quarry. This quarry, situated four-fifths of a mile south of the Kirkland quarry, differs only very slightly from those just described, although *Favosites sp.* and *Pterinea emacerata* (Conrad) appear here in addition to the characteristic fossils found in the other quarries. Occasional segregations of light yellow sphalerite and dark amethystine fluorite are found in the upper part of the quarry section, usually as a replacement in *Stromatopora (Syringostroma)*. Also, in the lower part of the lower quarry, occasional stratiform lenses of black flint occur.

The quarry measures about 200 feet by 100 feet, with a face of 22 feet. Vertical joint planes trending N. 45° E. and N. 65° W. are conspicuous. The section presents a series of dark blue fossiliferous limestones, weathering light gray, varying from a fraction of an inch to ten inches in thickness, with fissile dark carbonaceous shale partings. Some of the strata in the upper quarry, measuring one inch in thickness, are of nodular character. The floor of the upper quarry is characterized by depressions and elevations, which might have been produced by interference ripples and resemble Kindle's "tadpole nests" (Twenhofel, 1932, p. 659).

Cittadino quarries. These active quarries, located on Paris hill, about one-half of a mile northwest of the village of Paris, have long been interesting collecting grounds for geologists, and of some economic value to the city of Utica for its building stone and road metal. There are two quarries here, the lower one measuring 300 feet by 150 feet by 38 feet and the upper one, of less areal extent, measuring 24 feet in height. The lower quarry is characterized by dark blue, well-stratified, compact limestone, with strata three to eight inches thick and relatively free from shale partings. When struck with a hammer the rock rings and releases a fetid odor characteristic of the Manlius. In the upper quarry there are 20 feet of this hard, blue fetid limestone, with thin beds consisting of granulated and reworked fossil parts. This is followed above by three to four feet of ribbon limestone, which in turn is followed by 20 feet of chunky and concretionary limestone suggesting the Clark Reservation member.

No waterlime member has so far been observed in this series, unless fragments of an interformational conglomerate at the base of the Manlius represent the Elmwood waterlime found at the base of the Manlius toward the west. Such a conglomerate would indicate very shallow waters or even a break in sedimentation. In this same zone light colored, oval-shaped bodies or pebbles of calcareous sandy rock are present, an occurrence which would corroborate the assumption of a break in sedimentation. It would appear that such a zone might very well represent a disconformity between two limestone formations, the lower one consisting of hard limestone and the upper of a more crystalline variety. The only two limestone formations found here are the Manlius and the Coeymans, unless the upper part is Jamesville and the lower part the Clark Reservation and Olney.

It is difficult to estimate the thickness of the Manlius where we have no contact with the underlying waterlime series, and no section greater than 38 feet has been found in any one locality. A rough estimate of total thickness would be somewhat greater than 150 feet.

Stylolites are found in the Manlius in the ribbon limestone. Vertical joint planes running N. 15° E. and east-west, as well as S. 55° E., and dipping N. 65° E. are exposed in these quarries.

Glacial striations trending N. 25°-35° W. grave the edges of the quarry. The common fossils found here are *Buthothrepis gracilis* (Hall), *Favosites helderbergiae* Hall, *Tentaculites gyracanthus* (Eaton) Hall, *Stropheodonta varistriata* (Conrad), *Pterinea securiformis* (Hall), *Schuchertella subplana* (Conrad) and *Spirifer vanuxemi* Hall. Favosites and tails of *Dalmanites limulurus* (Green) are generally found just beneath the zone of disconformity and below this in the Manlius.

DEVONIAN SYSTEM

Coeymans Limestone

If the crystalline limestones of the above described quarries on the west side of the Oriskany really show the characteristic features of the Coeymans, we should expect representatives of the typical Coeymans fauna, such as *Sieberella coeymanensis* Schuchert, which so far has not been observed. If the identification of the Coeymans depends upon this particular fauna, then the Coeymans is not present, and all we have is the Jamesville division of the Manlius. It is quite possible that these beds above the Olney, that is, the crystalline limestones, are really transition beds between the Manlius and the Coeymans. So far as the eastern side of the Oriskany valley is concerned, in the Cittadino quarry, the slight evidence of a break in these limestones may be sufficient reason for separating the Manlius and the Coeymans at that locality. It would appear that an estimated thickness of 50 to 60 feet for the Coeymans would be adequate. Corals and crinoid columnals are more abundant in the crystalline parts than has generally been considered characteristic of the Coeymans for this region.

A chart showing the occurrence of the fauna of the Manlius-Coeymans formations in the quarries described follows:

	Prospect hill	Eisler quarry	Kirkland quarry	Lawless quarry	Cittadino quarry
Plants					
Buthothrepis gracilis (Hall)....	..	x	x	..	x
Hydrocorallines					
Stromatopora (Syringostroma) barretti Girty	..	x	x	x	x
Corals					
Favosites proximus Hall........	x	..	..	x	..
F. helderbergiae Hall...........	..	..	..	..	x
Graptolites					
Inocaulis (?)	..	x	x	x	..
Crinoids					
Stems and columnals...........	..	..	..	x	x
Bryozoans					
Monotrypella arbuscula (Hall)..	..	x	..	..	x
Brachiopods					
Meristella laevis (Vanuxem)....	..	x	..	..	..
Spirifer vanuxemi (Hall).......	..	x	x	x	..
Stropheodonta varistriata (Conrad)	..	x	x	x	x
Schuchertella subplana (Conrad)	..	..	..	..	x
S. interstriata (Hall)...........	x	..	..	..	..
Pelecypods					
Pterinea emacerata (Conrad)...	..	..	..	x	x
P. securiformis (Hall).........	..	..	..	..	x
Gastropods					
Phanerotinus laxus (Hall)......	..	x	..	..	..
Diaphorostoma niagarense Hall..	..	..	..	x	..
Loxonema fitchi Hall...........	x	..	..	..	..
Pteropods					
Tentaculites gyracanthus (Eaton) Hall	..	..	x	..	x
Ostracods					
Leperditia alta (Conrad).......	x	x	x	..	..
Trilobites					
Dalmanites limulurus (Green)..	..	..	..	..	x

Some of the more important fossils of the upper Silurian, including the Bertie waterlime and several members of the Manlius, are shown in figure 31.

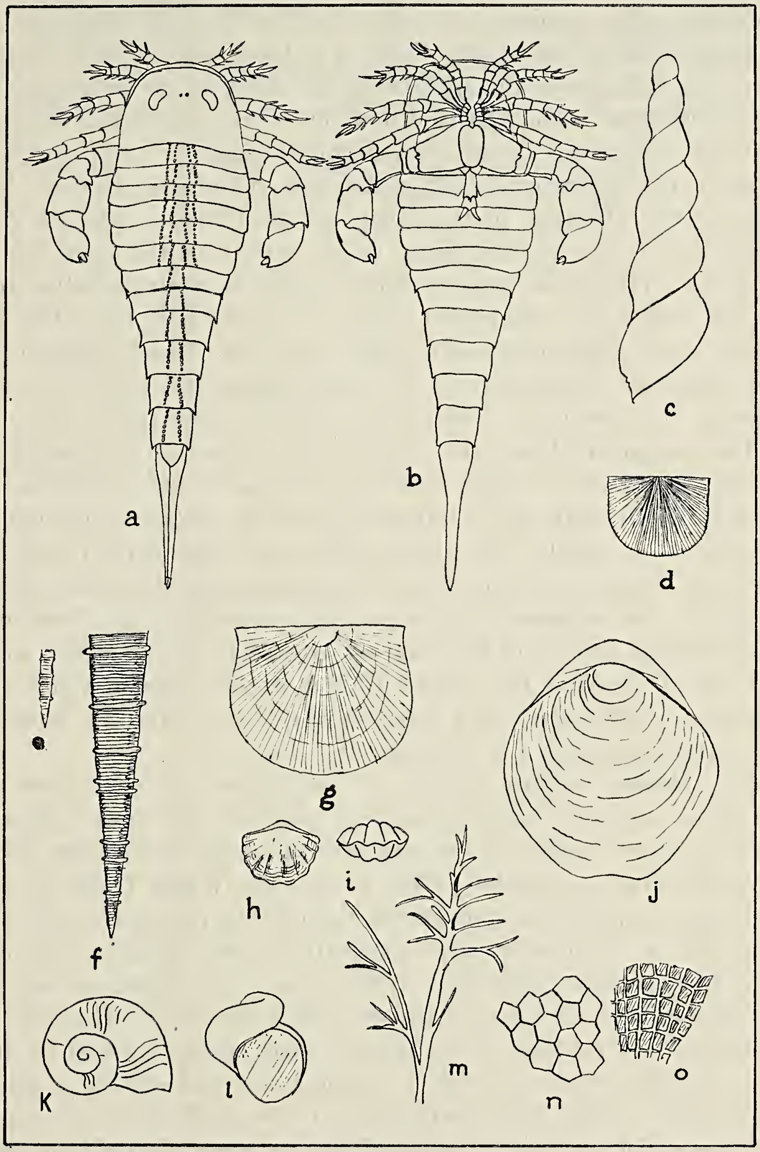


Figure 31 Upper Silurian fossils. (Eurypterid, *a, b;* gastropods, *c, k, l;* brachiopods, *d, g, h, i, j;* pteropod, *e, f;* sea weed, *m;* coral, *n, o*). *a, b Eurypterus remipes. c Loxonema fitchi. d Schuchertella interstriata. e, f Tentaculites gyracanthus,* with enlargement, x 10. *g Stropheodonta varistriata. h, i "Spirifer" vanuxemi. j Meristella laevis. k, l Diaphorostoma niagarense. m Buthotrephis gracilis. n, o Favosites helderbergiae.* (Drawings by V. Caldwell)

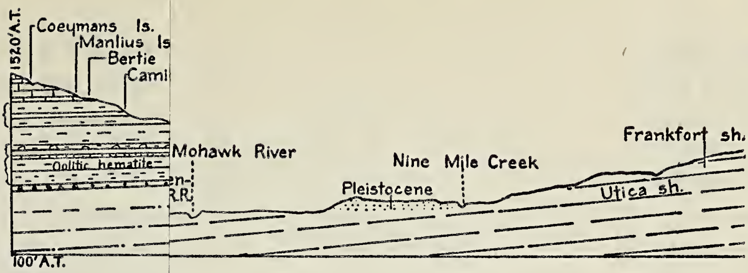
STRUCTURAL GEOLOGY

Reference to the areal geological map and columnar section shows that we are dealing with a relatively simple series of stratified sedimentary rocks ranging from the Utica of the Ordovician to the Coeymans of the Devonian. There is in these beds an inclination of less than a degree to the south with the oldest of the series exposed in the Mohawk valley lowland and the tributary valleys, while the Silurian formations occur on the inface slopes of the Allegheny cuesta. The Ordovician formations occur mainly in the inner lowland of the Mohawk, in the valleys of the Oriskany and the Sauquoit and in the outface slope of the cuesta to the north of the Mohawk. The cuesta was developed largely through the adjustment of the Mohawk, a subsequent stream, upon the soft Frankfort and Utica shales; the north-south valleys were developed originally by the consequent headwaters of the Susquehanna and later by its successors, the obsequent Oriskany and the Sauquoit (figure 32).

The fundamental structure of this area is that of a homocline in which the strata of shale, limestone, dolomite and sandstone dip slightly to the south and southwest becoming progressively younger from north to south. The regional dip varies considerably over the area, due largely to the presence of superimposed structures, among which may be mentioned the monocline just north of the Borst mine and Stebbins creek and the anticline on Prospect hill. Slopes of 23 feet and 46 feet to a mile on the Clinton in the Sauquoit valley, and 46 feet on the Bertie, in a south-southwesterly direction, however, have also been noted for the town of Augusta.

No evidence of large, gentle and continuous folds has been observed in this area, such as has been noted in the Ithaca region by Harris and the region to the southwest in south central New York, later described by Kindle (1909, p. 98) and Wedel (1932, p. 35). This may in part be accounted for through the presence of the drift and lack of sufficiently large exposures where suitable and accurate measurements could have been taken. As a matter of fact the strata over most of the area varied so little from the horizontal attitude that if a reading of five degrees were made it would be difficult to differentiate between a regional dip and one of a purely local nature. The full significance of the small dip, however, is not lost sight of, and it is hoped that at some future time some intensive work may be done with this phase of structural geology.

Important variations from the regional strike and dip are found in connection with the conspicuous southwesterly dip of the beds of the Oneida formation a mile northeast of Clinton and just east



Fe 75°21′ meridian. Horizontal scale: ½ inch
to 1 m

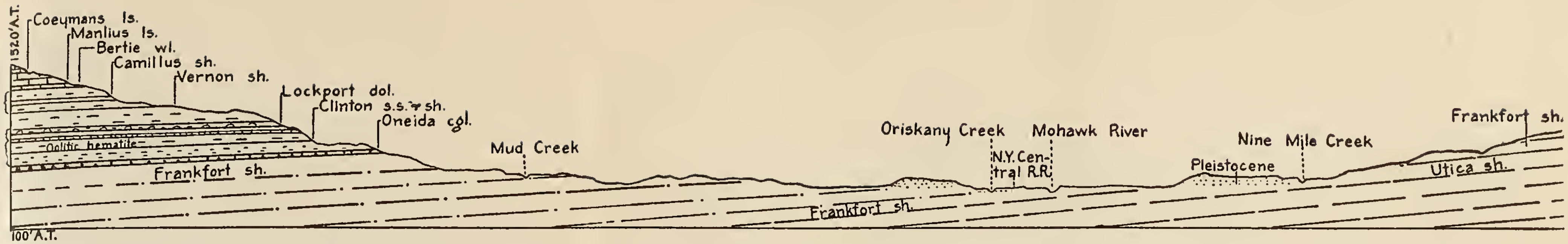


Figure 32 Profile and cross section through Mohawk valley and Allegheny cuesta along the 75°21′ meridian. Horizontal scale: ½ inch to 1 mile; Vertical scale: ½ inch to 700 feet. (Drawn by N. C. Dale)

of the Clinton-Utica road. The beds dip 22 degrees to the southwest and strike N. 55° W. at this locality but the formation resumes its regional attitude along the outcrop to the northeast at "Rock City." In the brook bed 700 feet to the southwest and topographically lower the middle Clinton shale was found in its regional attitude, necessitating the same for the underlying Clinton. As shown on the areal map the axis of the monocline should be nearly east-west and southeast in direction, though it is difficult to say how far to the northeast and southwest this fold continues or how much area is involved. This being true, it should be expected that the overlying formation is involved in the movement, which appears to be the case, as shown in the plicated condition of the overlying shales of the middle Clinton along the axis in Stebbins creek. Other evidences of this monocline are seen in the inclined dolomite lentils of the shale and the ore bed itself at the stripping where Stebbins creek crosses the stripping one-half of a mile east of the mine. Southwesterly dips of 12 to 15 degrees are noted for these beds.

The Oneida and Frankfort exposed one mile to the east along the next north-flowing tributary show southwesterly dips of 15 degrees and appear to belong to this same monoclinal folding as described above. On Prospect hill and to the south dips of eight degrees show small anticlinal development with a northwest strike. Such a small anticline is seen in the town of Kirkland quarry at the base of Prospect hill.

Some normal faulting with small throws measuring up to two and one-half feet has been noted, principally in the neighborhood of Lairdsville and Hecla, those along Lairdsville gorge having throws of only a few inches. The interesting feature of this Lairdsville occurrence and the Clinton monocline is the 45-degree relationship between the axis of the Lairdsville faulting and that of the monocline. One would naturally suppose, in view of this angular relationship, that each type of deformation was the product of a separate movement, but they might very well have been produced by one common movement, presumably of a rotational sort. The folds and faults of northeast trend, however, would naturally reflect the typical structures to the south in the Allegheny plateau as well as in the more recently folded Appalachians, while those of northwest trend were more of a resultant type.

It is believed that the faulting in this area must have succeeded the jointing, because the joint planes in the Lairdsville district show distinct signs of having taken part in this movement, as seen in the frictional features on the joint faces. No great difference in time need be required for the production of these features even if initiated by the same movement.

Would separate movements be necessary for the emergence of the plateau and the folding as seen here? Kindle (1909, p. 98) believes that the tilting of the Appalachian plateau was brought about by the Canadian uplift at the close of the Devonian. In view of the absence of post-Devonian sediments over most of New York, which means that deposition in this region had largely ceased at the close of the Devonian, it would appear, according to Wedel (1932, p. 35), that "there must have been differential uplift during the period, which tilted the strata to the south and raised this area above sea-level. This southward tilt would, of course, be accentuated by continued down-sinking of the Appalachian depositional trough, which is known to have been an area of sedimentary accumulation to the close of the Pennsylvanian and in places even into the Permian." If the above view is correct, it follows that the slight amount of folding and faulting found in the Oriskany area was superimposed upon a regional uplift already present, the folding being a part of the Appalachian orogeny.

As evidence of movement along joint planes no better illustration comes to mind than that furnished by the Vernon formation, and the middle Clinton at Lairdsville to a less extent. The common major and subordinate joint planes in the rocks of this section have directions as follows: N. 15° E., N. 60° E., N. 50° E., E.-W., N. 75° W. and N. 60° W. The east-west trending planes are found throughout nearly all the formations. With the exception of those found in the Vernon most of these planes are of the tensional variety, while some of those which are slickensided in the Vernon are probably due to compressional movements. As shown in the accompanying figure the major joint planes in some cases appear to be associated with sets of discontinuous parallel planes and some which are curved and bifurcating. Furthermore, the N. 65° W., north, south, and many northeast and southeast dipping planes show marked slickensides. It would appear that some movement deforming beyond the ordinary tension producing forces must have been responsible for the many curved and slickensided joint planes. In a previous chapter (page 108), the writer has pointed out that the Vernon thickened from 160 feet (estimated) in the Sauquoit valley to 340 feet in the Oriskany valley. Such rapid thickening in the short distance of six miles would lead one to speculate as to the cause. If the Vernon was originally deposited in lenslike form, no further explanation for this thickening need concern us, but as much of the increase in thickness appears to be concentrated along Kirkland ravine, some other explanation is to be looked for. This incompetent formation, the weakest member in the whole series, in fact, when subjected to side pressures would reflect this sort of movement, at least along the joint planes already formed, if not by overthrusting, thereby causing an apparent thickening; but no evidence of this condition has come to light at present.

Joints in the Utica shale are clean cut and as a rule, vertical, though planes steeply dipping S. 80° E. and S. 85° W. are found. The more frequently occurring joint planes are those with the following strikes: N. 20° E., N. 60° E., N. 25° W. and E.-W. Those striking N. 20° E. and N. 60° E. are generally the types which control the courses of the streams on the brinks of waterfalls. The scarcity of inclined joint planes would lead one to infer that the vertical ones are largely of a tensional variety. North of Holland Patent, in the bed of the brook where the upper Utica is well-exposed, the highly inclined joint planes striking N. 60° E., however, appear to be associated with considerable deformation in the shales at that point.

HISTORICAL GEOLOGY

The geological history of the Oriskany area has been discussed to some extent throughout many other chapters. It is treated under such headings as stratigraphy, paleontology, glaciology and economic geology. Therefore it seems best to assemble this scattered data into a brief account, arranged in chronological order.

PRECAMBRIAN

Though the oldest rocks outcropping in this area are of Ordovician age, it is well to deal briefly with the pre-Ordovician types. The nearest exposures of Precambrian rocks in this vicinity are at Little Falls, some 30 miles to the east, and at Forestport, an equal distance to the north. Well drilling at Baggs Square, Utica, by J. H. Foley, well-driller, shows granite at 1300 feet overlain by Potsdam and Theresa sandstones, Little Falls dolomite, Trenton limestone, Utica shale and Pleistocene sand and gravel. The petrology and structural geology of the Precambrian rocks underlying our area are undoubtedly similar in a general way to those of the occurrences at Little Falls, at Forestport and in the general Adirondack province, but the history of those rocks is too complex a matter for presentation in this report except in a very brief manner.

It has been shown by Ruedemann (1922, p. 65-152) and others working in the Adirondacks that the orderly arrangement of the folds in the Precambrian, produced by forces originating from nearest ocean depth and hence heavier than the continent, was parallel to and controlled structurally by the outline of the continent. As the major trend line of the folds is northeast for most of the Adirondacks, the same presumably holds true for the Precambrian rocks underlying the Oriskany area of the Allegheny cuesta. Along with the general northeast folding several long northeast-southwest barriers and troughs were produced during the Archeozoic and two geosynclinal basins during the Proterozoic, which later, as they became filled by sediments from the mountains, suffered subsidence and subsequent folding. At least two troughs are distinguished, the eastern or Levis trough and the western or Chazy trough, but we are concerned only with the Chazy. As these troughs persisted through Ordovician times, they reflected the frequent inundations and oscillations of the land beginning with the Cambrian. A very long period of erosion, however, took place before any Cambrian sediments were deposited as is shown in the classic unconformity separating the Precambrian rocks from the overlying sediments at Little Falls.

CAMBRIAN

Well records in Utica and vicinity show the absence of Lower and Middle Cambrian rocks; only the uppermost Cambrian beds (Ozarkian of some authors), consisting of the Potsdam sandstone and Little Falls dolomite, are present. "Until Ozarkian [Upper Cambrian] time, the western trough remained dry. The first deposits in this trough were coarse quartzose sands and gravels, the Potsdam sandstone, the accumulation of which (in shallow marine waters) started in the northeast in Clinton county and continued progressively to the west and to the south. . . . Ruedemann describes the climate as arid and the land as a desert without vegetation. 'The land to the west and south had strong relief and vigorous currents transported the coarse sands and gravels into the basin'" (Goldring, 1935, p. 202). Under this area more of the Potsdam sandstone and Theresa should be expected and less of the Little Falls dolomite than occurs at Little Falls. (See Campbell Well section, p. 181.)

Following this deposition there was a gentle uplift which brought the Chazy trough above sea level and initiated the erosion that resulted in low relief.

ORDOVICIAN

Nearly all of the upper half of the Oriskany quadrangle is immediately underlain by the Utica, Frankfort and Pulaski of Upper

Ordovician age, and probably some 350 feet of limestones, comprising in all probability the Lowville, Black River and Trenton beds. The upper part of the Trenton limestone is represented in the lower Mohawk valley by the Schenectady beds, over 2000 feet thick and the Canajoharie black shales with a thickness of over 1200 feet, indicating clear marine conditions farther out in the shallow epicontinental Trenton sea. According to Ruedemann (1930, p. 170):

> . . . the same Trenton sea may have deposited Schenectady beds in the [Albany] capital district, black shales in the near north and west and Trenton limestone farther away. This deposition may have continued even into early Utica time. The principal portion of Utica time is, however, not represented in either the eastern or western basins, and the true Utica shale is found only in the middle and upper Mohawk valley. If there was any coarser shore deposit of the Utica other than the upper Schenectady, it has been entirely eroded away.

Some 800 feet or more of Utica and Frankfort shales of the Upper Ordovician are overlain by a thin sandy zone of the Pulaski, indicating a great influx of black and gray sandy muds characterized by graptolites, pelecypods, cephalopods and trilobites. The source of these muds may have been some high land to the east, such as Taconia, as suggested by Schuchert. It would appear that the Ordovician rocks as represented in central New York are regressive, indicating a gradual uplift of the land during which clear marine conditions of the Trenton were progressively replaced by clastic sediments in the west, finally culminating in an epirogenic movement in this area and an orogenic movement in the east as shown by the Taconic mountains. The disconformity separating the Ordovician from the Silurian, shown at the various Oneida-Frankfort contacts, demonstrates this emergence in central New York.

SILURIAN

A long period of erosion followed the late Ordovician emergence, resulting in a surface of low relief over which the Silurian sea advanced and deposited the Oneida conglomerate, basal member of a rock series, extremely varied though predominantly clastic. With the close of the Ordovician the Chazy trough ceased to function and the succeeding Silurian seas advanced far over and beyond it. In Clinton times alone, though the section at Clinton shows the rocks to be predominantly clastic and of shallow water origin such as obtains in lagoons, there are important and interesting zones of oölitic hematite and "red flux" and subordinate lentils of oölitic chamosite and phosphate depicting the type of submarine chemistry of the shallow sea bottom. The varied organic life of the Clinton, as shown in its molluscan and crustacean fauna, has long distinguished this formation. The shale and dolomite lentils, which indicate an oscillating condition of the Lower Clinton sea bottom, give place in the Upper Clinton to prevailing sandy dolomites, indicating more stable marine conditions. Different conditions prevailed in the Clinton sea going westward, as various attempts at correlation have shown.

Continuing shallow water marine conditions prevailed during the Lockport phase of the Niagaran epoch, which is represented in this region only by some 40 to 60 feet of shale with intercalated dolomitic algal reefs.

According to Ruedemann (1930, p. 172), "The greater thickness and development of the Salina formations eastward and especially westward seem to indicate that there was a barrier in the capital district and its neighborhood, which frequently interrupted the ingress of the sea, from the southwest, about where New Jersey is today." In this area, where the Salinan measures between 600 and 700 feet and represents deposits in the eastern end of a depression stretching from western New York to Michigan, though red shale prevails in the Vernon, with rare waterlimes and a drab limy shale in the Camillus with occasional red and green mottled sandy shale members bearing traces of salt and gypsum and greater thicknesses of waterlime toward the top, the rocks show unmistakable evidences of gradual replacement of desert conditions by marine conditions toward the top.

The Manlius limestone with a computed total thickness of approximately 160 feet based upon the several exposures from Prospect hill southward to Paris shows the full return of the sea, the underlying waterlimes apparently indicating only partial return though an eurypterid and ostracod fauna are present. The Manlius sea spreading westward and also southward in a narrow trough to Tennessee differed from that of the Salinan in that it had a free connection with the ocean (Ruedemann, 1930, p. 172). Small spirifers, ostracods, lamellibranchs, corals and gastropods associated with the *Stromatopora* beds (*ibid.*, p. 173), suggest that this formation was deposited between and behind coral reefs.

DEVONIAN

A disconformable contact between the Manlius and the Coeymans on Paris hill indicates a brief withdrawal of the sea in these parts but the Coeymans sea, according to Ruedemann, did not differ materially from that of the Manlius in general outline and location. Corals, crinoids and some trilobites favored this sea. Whether the succeeding deposits of the Helderbergian sea and other Devonian formations were ever laid down in this region can not be proved definitely though there is no reason to believe that the massive middle and upper Devonian did not extend beyond this region on to the Adirondack slopes. For a fuller discussion of the Devonian history, the reader is referred to Goldring's account (1935, p. 207-15).

CARBONIFEROUS

There were no more marine invasions in this part of New York State though some took place in the Mississippian and Pennsylvanian periods in the southwestern part of the State where scattering and outlying masses of the oldest Pennsylvanian unconformably overlie the oldest Mississippian formation. How far these Carboniferous seas extended over southern New York is not known.

Of course not far from the southern boundary of New York the rich coal producing swamps existed and according to Ruedemann (1930, p. 177):

> There is no doubt that a large portion of these formations, also, once extended into our district, and that for all we know luxuriant swamp forests of the coal period may have flourished here [the capital district] as well as in Pennsylvania, for, if we consider that the capital district was exposed to the gradational work of the wind and weather ever since the Carboniferous period, that is for 300 millions of years as geological time is figured now, it is readily seen that an enormous amount of material above the . . . [Upper Devonian] beds must have been removed in this long time.

If this is true of the capital district, it would also hold true for the Oriskany area as well.

The close of the Carboniferous was marked by a mountain-making disturbance of world-wide occurrence which resulted in the formation of the Appalachians and the raising of the Appalachian or Allegheny plateau nearly to its present elevation above the sea, as well as the production of the folds, faults and joint planes which characterize so many parts of it. In other words the plateau character was given to it at this time.

Erosion set in contemporaneously with the raising of this great plateau, in all probability, resulting in the stripping of the overlapping southward dipping strata from the Adirondacks and consequent migration southward of the cuestas, the steeper escarpment facing the inner lowlands as seen in the present Allegheny cuesta with its inface slope or escarpment. In the Mohawk valley it is difficult to estimate the exact thickness of the strata, but it is believed that a thickness of one or two miles has been removed from the site of the valley.

MESOZOIC

Except for certain troughs in eastern New York and New Jersey most of New York was undergoing a profound erosion, the products of which were deposited along the New Jersey and New York shores and in several troughlike depressions. The Cretaceous deposits of Long Island and Staten Island are such beds, and also the Newark series (Triassic) of New Jersey. In east central New York, however, the story of the Mesozoic era is one of erosion, though parts of New York may have been elevated and faulted prior to or coincidently with erosion. Important marine transgressions and mountain-making movements, however, were affecting other parts of the United States.

As sedimentation was the principal feature of the eastern coastal plain region during Cretaceous times, certainly some erosion must have been taking place in this part of New York State, but whether the oldest surviving peneplain, the Schooley, was completed by the end of the Mesozoic is a much debated question. Some are inclined to date its culmination somewhere in Miocene times. As Fenneman remarks (1938, p. 257): "There may well have been a Cretaceous peneplain at the end of an erosion cycle which corresponded to the cycle of sedimentation on the Coastal Plain in Jurassic-Cretaceous time. The peneplain that is known to exist beneath the coastal plain sediments must, of necessity, be older than the sediments resting on it." Such a statement, though written for the Ridge and Valley province, may well apply to the Appalachian Plateau province.

CENOZOIC

Most Adirondack geologists are in agreement with the conclusions of Cushing and Ruedemann in their study of the Saratoga district (1914, p. 145), namely, that "at the close of the Mesozoic the region was again uplifted. The low altitude peneplain which had been produced over the Adirondack region was elevated some 1500 feet or more, and rapid erosion of its surface began. Stream valleys were cut down and broadened. It is the depth of the valley cutting below the old peneplain level which enables us to estimate the amount of uplift. The old peneplain surface is readily made out over most of the Adirondack surface." Figure 4 shows the profile and section from the Adirondack province southward through this area and likewise indicates that the Oriskany area would of necessity show no trace of the Schooley peneplain, being far below the original surface as the result of excessive erosion along the site of the inner lowland and the inface slope of the Allegheny cuesta.

According to Cushing and Ruedemann (*ref. cit.*, p. 181), "during the first part of the Cenozoic, the Tertiary, minor oscillations of level took place in the region, but we lack the precise knowledge of just where and what they were. Later in Tertiary times an additional uplift took place, considerably increasing the altitude of the region." If true for the Saratoga region, this undoubtedly applies to the Oriskany quadrangle as well. It is possible also that the Mohawk valley lowland and connecting tributary valley floors represent the third and latest peneplain, as seen in the Albany district, with elevations of 100 to 600 feet, while the higher points near the Mohawk-Susquehanna divide, around 1600 feet, may represent the Harrisburg peneplain. If the 4000 foot elevation of the Catskills represents the Kittatinny or Schooley peneplain and can be correlated with the tops of the Adirondacks and Green mountains, this region must, of course, be conspicuously below that level, but if this elevation is "1500 or 2000 feet higher than what is believed to be the Schooley surface on Shawangunk mountain or in the Adirondacks or New England or North Eastern Pennsylvania" (Fenneman, 1938, p. 322), then the higher elevations in this region, such as Paris hill, may approach it while those along the Susquehanna-Mohawk divide may represent the remnants of the Schooley peneplain in east central New York. In any event there appear to be records of two peneplains both of which may very well have been initiated in Tertiary or early Cenozoic times.

While these erosional processes were under way, the major agents of this erosion, the rivers, must have been undergoing some very unusual changes. In order to appreciate these great changes which took place in the development of the drainage in central New York, it will be necessary for us to visualize the environment of this area after it was uplifted from the great interior sea in upper Carboniferous or Pennsylvanian times. The first streams which developed in this area rose in Canada and flowed south as consequent streams across a series of beds of varying composition but dominantly shale, dipping very gently to the south and finally emptied into the gradually disappearing epicontinental sea south and southwest of New York State. The surface which was undergoing uplift and weak folding at the close of the Permian must have affected these primitive streams very profoundly, but of this we have no knowledge because erosion during the long succeeding era of the Mesozoic has erased such effects. These primitive rivers must have passed through several cycles of development and, in a regional way, must have been responsible for the highest and oldest of the peneplains, the Schooley, which some believe could not have been completely developed until middle Miocene times. Whether or not the full peneplanation was accomplished in Mesozoic or Tertiary times both the Mohawk river and its tributaries were believed to have undergone some drainage and topographic changes during the first part of the Cenozoic era.

During the development of this primitive consequent drainage in Tertiary times, if not before, down and along the slope of the gently dipping and overlapping sedimentaries from Canada through New York, certain east and west tributary streams, such as the Rome and Mohawk, began to flow and etch valleys for themselves along the strike between the Hudson and the Susquehanna. Through headward erosion these subsequent tributaries eventually reached a high point or divide established at Little Falls as the result of faulting at the close of the Permian period. The west-flowing stream, sometimes referred to as the Rome river, in its gradual development absorbed and diverted the headwaters of the Susquehanna north of this area to the older expanding Ontarian system which had been extending its tributaries from the basin which Lake Ontario and Oneida lake now occupy and eastward. This piracy of the Susquehanna and the consequent etching of the Mohawk Valley trench must have been responsible for the reversal from the south-flowing drainage of the Susquehanna to the north-flowing drainage of the new and short tributaries draining the south side of the valley or the inface slope of the Allegheny cuesta. This drainage reversal and cuesta development must necessarily have involved many thousands of years together with uplifts which naturally would accelerate the work through rejuvenated streams. Still the Rome river and its new young obsequent tributaries were a part of the Ontarian system which may have drained into the Mississippi at this time, through its master stream which antedated the younger tributaries just referred to.

The early Susquehanna, Hudson and other streams consequent upon the great Adirondack mass were all part of a great radial system of drainage which was interrupted in its development by a system of tangential streams such as the Mohawk, Black, St Lawrence, Lake Champlain and Hudson in very much the same manner that the Susquehanna was probably interrupted in its development by the extension of the Ontarian system, with resultant piracy. The name "glint" which Ruedemann has applied to these tangential cuesta-forming streams is very appropriate (1931, p. 434). For a fuller discussion of the development of the drainage the reader should consult Ruedemann's paper.

Proofs of the existence of these very early consequent Susquehanna valleys north of the Susquehanna-Mohawk-Hudson divide still await us but Fairchild thinks that it would not be too unreasonable to consider the valleys north of the Mohawk as the line of flow of the headwaters of the Susquehanna and those leading south from the cols on the divide as the Tertiary valleys (1925, p. 25) and a continuation of those on the north.

PLEISTOCENE

The disappearance of the ice sheet some 20 to 25 thousand years ago left in this area some very direct evidence of its presence. Prior to the last advance of the Continental Ice Sheet of the Wisconsin age, this area was covered with a regolith or mantle consisting of loose fragments of the underlying rocks just above the bedrock, with finer grain material above constituting a residual soil, like all the present unglaciated areas of the world. Of course, all the loose overburden must have originated in the immediately underlying rocks, through the decomposition and transportation of the more soluble components, leaving only the less soluble in the form of clays etc. in place. Such a region typifies all the areas south of the glaciated area in this country, and the driftless area of the west. How thick this overlying material must have been we have no way of knowing, though the thickness of any residual soil would depend much upon the nature of the underlying rock, as well as the climate and vegetation. The preglacial topography must have possessed a lower relief in some parts than it does today, because of the evolution of the drainage. Certainly the Mohawk valley must have been less of a trench when the Ontarian River system and the Mohawk were heading toward Little Falls, and the Allegheny cuesta began to take form in Tertiary times. With the obliteration of the river systems by ice, and reduced gradients brought about by depression of the land, followed by the retreat of the ice, and the formation of proglacial lakes at the edge of the melting ice, as well as by the glacial Mohawk and the Iro-Mohawk rivers, marked changes in the greater part of the relief of the valley were made. The most obvious change had to do with the filling so far as we can judge today.

The present relief could hardly have been developed in Tertiary times, although the initial beheading of the Susquehanna must have taken place then. Then with the coalescence of the Rome and Mohawk rivers at the Little Falls divide in the Pleistocene, brought about by the powerful erosive forces of the waters coming from the Great lakes when the ice blocked the St Lawrence spillway, certainly marked changes must have been made in the Mohawk valley

As these changes were largely postglacial in age, it is only necessary to show the possibility of greater topographic changes subsequent to the ice advance than before. The ice did not destroy the pre-existing topography other than the soil top; but there was a total modification of pre-existing topography by accentuation of the depths and widths of the valley in favorably situated places and through deposition in other places. This is certainly true of the Mohawk valley, as shown by the topography above the river level and deposits below, determined by borings. As a result of the destructive action of the ice, needless to say, the valley must have been deepened and widened, because of the nonresistant character of the rocks here concerned; and as a result of its constructive action the valley must have been made more shallow. Both of these effects can be seen in parts of the Mohawk valley. Whichever way the ice was moving, either in the preliminary stages or in the more restricted later stages, it must have eroded the rocks along which it flowed, shod as it was with fragments of rock which it plucked in its movement south. Some of the records of this movement are seen in the striations or etched pavements, in the various parts of the Oriskany area, especially as they were made by sharp points of rock fragments held in the bottom part of the ice. These markings are best seen on the Manlius and Coeymans limestone exposures, the Clinton dolomite and Oneida conglomerate. None were observed in the shales for very obvious reasons. It is believed that these striations are the record of the last advance of the ice during the Wisconsin epoch, and very probably represent the different parts of the ice sheets or zones as the ice sheet moved over the more impressionable formations. As shown by the areal map, the striations in the Oriskany valley and the higher points of the plateau range from S. 8° E. to S. 40° E. In the Munnsville area, which is off the quadrangle to the west, the direction of the striae are S. 90° W. and S. 10° W. on the Manlius and Coeymans formations, while to the north of Rome, north near Lowell and slightly west of this area and on the Oneida sheet, striations on the Oneida exposure trend S. 85° W. The Lowell striations appear to indicate that the Mohawk Valley ice lobe must have been still in existence as far west as Lowell. The other striations, the general average direction of which was S. 25° E., were undoubtedly produced by an earlier phase of the Wisconsin advance, probably the west-moving "lobe" or strait as suggested by Brigham (1931, p. 184). It is quite possible that these southeast trending striations do not reflect the influence of the Adirondack ice mass, because the general direction of movement at the height of glaciation was southwest, but the St Lawrence ice mass moved around the west side of the Adirondacks. The ice mass which passed over the Adirondacks, or at least within 500 feet of the top of Mount Marcy, where boulders of Potsdam sandstone have been found, was probably responsible for the southerly and southwestern striations.

No other evidence on this sheet has been found to indicate the direction of the main mass of ice movement. Of course, the configuration of the valley established, in part, in preglacial times undoubtedly controlled a later stage of glaciation of these parts. Chamberlain (1883, p. 365) says:

I hesitate at this stage of the inquiry, to encourage any confident opinion in regard to the exact history of glacial movements in the Mohawk valley, farther than the general presumption that massive currents having their ulterior channels in the Champlain valley on the one hand, and the St Lawrence on the other, swept around the Adirondacks, and entered the Mohawk valley at either extremity, while a feebler current at the height of glaciation, probably passed over the Adirondacks, and gave to the whole a southern trend. It should not be overlooked that this valley lies sufficiently back from the average limit of glaciation to afford the presumption that the earlier and later movements may have been quite different. The striation of the immediate Mohawk valley may be the work of local currents developed on the margin of the retiring glacier.

The Lowell striations trending S. 85° W., although much lower in altitude than those which Brigham reports on the sandstone pylons 3 miles west of Bridgewater village, might still be due to a very local movement, but appear to be much farther west than Chamberlain's grooving record at South Columbia and Brigham's at Bridgewater village, in the meridian of Rome (Brigham, 1931, p. 185).

Just how much the Oriskany and Sauquoit valleys shared in the control of glacial movement, if at all, has not been determined. It would appear that the southeast movement would indicate little if any control, in view of the fact that the eastern slopes of these two valleys appear to be steeper than their western slopes. It is quite possible that the glacier may have had a more destructive effect on the eastern slopes than on the western or that more drift deposits were left on the western than on the eastern, but of this we have no proof as yet.

Glacial deposits. When the continental ice sheet melted, various deposits of an unstratified nature were revealed at the margins as well as in the path of the ice. These deposits were laid down directly by the ice and hence were without any sorting action. Such deposits are heterogeneous in composition consisting largely of boulders of variable composition and size set in a matrix of clay or even sand or a mixture of both. In shape the boulders are generally subangular and when fine-grained show polished and striated surfaces. The edgewise conglomerate of the Lockport dolomite formation exhibit these characteristics to a remarkable degree. Most of the boulders of the drift (unstratified) are of Precambrian and Lower Paleozoic types. Most of the Precambrian types are of Grenville and Post-Grenville sources of either the Adirondacks or the main Laurentian shield. Grenville marble, contorted rusty and other gneisses: injection, granite and garnet gneisses, anorthosites and gabbros and syenites have all been noted in the till sheet on the Hamilton College campus. Among the lower Paleozoics red Potsdam sandstone, Frankfort and other upper Ordovician calcareous rocks, Medina, Oneida, Clinton, Lockport, Bertie waterlime, Manlius and rarely, Oriskany sandstone have all been identified on College hill as well as other places on the quadrangle. Many of these types were a part of the drift but have been freed from it through erosion and weathering. The boulder of Oriskany sandstone, however, found in a ravine in the town of Augusta, was one of the largest, measuring over five feet in diameter, and may very well have been deposited directly by the ice. Most of the boulders referred to above may be found along the stream bottoms in the ravines.

Occasionally bodies of quicksand are found in the till as the one described on an earlier page, the origin of which is problematical.

The distribution of the drift is probably far more extensive than appears on the surface because much of the till in the lowlands is underlain by glaciofluvial material or deposits made by the waters of the melting ice or waters dammed by the ice in the lowlands. In the uplands above the 600-foot contour the till generally dominates.

The thickness of the drift on this quadrangle is variable and no attempt will be made to give an average thickness. The till sheet on the Hamilton College campus is 23 feet thick, while on top of Prospect hill it has a thickness of less than 5 feet; and until there are sections down to bedrock in many of the upland areas, as well as in the lowland, it will be impossible to give exact figures on the thickness of the unstratified drift.

Glaciofluvial deposits. These are deposits formed by and in the waters derived from the melting ice or by waters dammed by ice. The waters themselves were not entirely of ice origin though the ice and the deposits themselves, in part, were the impounding

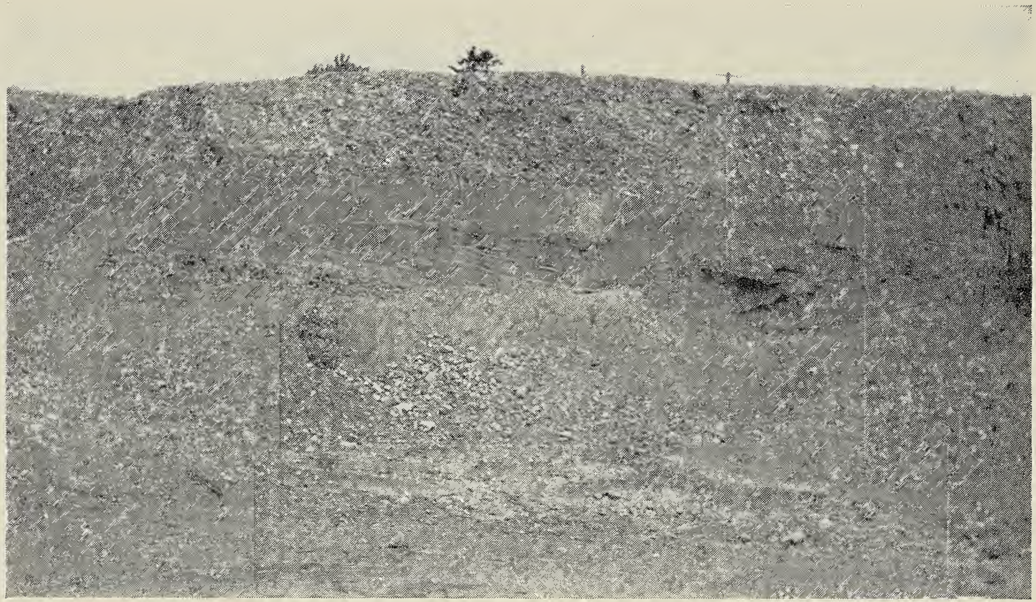


Figure 33 Section of Nick Sullivan's sand and gravel pit, Rome, N. Y. (Photograph by N. C. Dale)

agents. Undoubtedly, most of the material of these deposits were derived from glacial deposits and had been transported and deposited through the agency of glacial water. Either along the course of the ice sheet at its margins or in bodies of water associated with the ice of remote field, they have been more or less assorted and as a consequence show stratification planes or intermediate sizes. Separating may result in the formation of gravels or very fine sands. The deposits frequently show discordant stratification planes, indicating tumultous conditions of the flowing water.

As we have already indicated, most of the stratified glacial deposits are found in the lowlands between the 420 and 620 contours, that is generally along the valley bottoms and lower slopes of the Mohawk, its tributaries and the junctures. The plainlike areas about Rome, Floyd, Whitesboro, Oriskany, Coleman and Westmoreland are underlain by stratified sands and gravels, and doubtless represent old lake bottoms, marginal terraces, kame, kame terraces and other lesser types which it is our purpose to describe. Dr T. Wood Clark's relief model (now in the geological laboratory of Hamilton College) shows the location of the preglacial lakes.

The Rome-Floyd area. Over the site of the city of Rome and the divide looking west to the Oneida, between the Mohawk-Hudson and Wood Creek-St Lawrence drainage system, northwest and southwest for two or three miles, is an almost featureless or plainlike area at an elevation of 460 feet above tide. From this area there is a slight and gradual rise to the northeast and a much less gradual rise to the south. The area is so conspicuously flat as to suggest lake-bottom deposits. Its level character has been utilized by the New York Central tracks as they swing southwest from the city of Rome. The structure and composition of the area northwest of Rome at the elevation of 480 feet, as shown in Byam's gravel bed and Sullivan's sand and gravel pits (figure 33), clearly indicate the conditions under which, in part, this area was formed. The marked stratification, scour and fill features, cross-bedded nature and variation in thickness of strata within a short distance, all testify to deposition by running water and change in the velocity and load of the depositing medium. The more level reaches of the area reflect old lake-bottom conditions of Lake Iroquois and its predecessors, Lakes Dana and Dawson. All the lakes had their outlet at Rome by way of the Mohawk river, but the last and lowest outlet of all was the Iroquois outlet at Rome.

The higher, more terracelike features extending from Rome east to the town of Floyd and just north of the Mohawk river as far as the 600 and 620-foot contours at the base of Smith hill consist entirely of sand and gravel deposits. Only one excavation was noted in this area of some nine or ten square miles and this appeared to consist of unstratified sand and gravel. Brigham (1898, p. 196) in writing about the Rome-Floyd stagnant ice area says, "Its margin is much broken with some isolated talular masses and resembles the kame terraces. Its top surfaces as they appear on the atlas sheet, drawn to the 20-foot contour line, are much too uniform. The sections all show sand and gravel, with inclined and discordant stratification." In the view of the writer this area was not noticeably kamelike although undoubtedly, during the ice occupancy of the valley or the upland, marginal deposition from subglacial streams might very well have had a part in its formation. The writer is of the opinion that this body may be a composite mass, up to the 500-foot contour, made up in part of deposits consisting of the Nine Mile Creek and Mohawk River deltas and deposits by such higher Iroquois waters as Lakes Dawson, Dana and Amsterdam, as well as by the Mohawk ice and that part of the ice which lay above and was responsible for waters which flowed into the Mohawk from the north. When the four sheets, Oriskany, Remsen, Camden and Oneida are reviewed together, it would appear that their marginal terrace features might very well have been under the influence of subglacial streams, glacial lakes and river deltas.

Nine Mile delta. This feature extends from Holland Patent at an altitude of 600 feet almost fan-wise to the Mohawk, and represents the glaciofluvial deposits of the former West Canada creek, now occupied by Nine Mile creek. It has a length of practically five and one-half miles to the Mohawk flood plain where it terminates in a level terracelike feature 520 feet A. T., 100 feet above the flood plain of the Mohawk. At its frontal edge the delta widens from three to five miles if the Marcy terrace mass is a part of it. In describing this delta, Brigham (1898, p. 196) wrote:

> It is narrow at Holland Patent, but widens symmetrically the three miles at its frontal edge or if, as is probable, a massive bench of drift to the southeast is genetically connected with it, the width should be put at five miles. Its surfaces are exceedingly smooth and the mass is beautifully dissected to the bottom. The materials are coarser toward the head, and at the front consist extensively, so far as seen, of fine sand, which at two points is kept bare by the action of the wind. The drift mantles a floor of Trenton limestone and Utica shale and is of no great thickness, except toward the front. To the south and east runs the very massive shelf of drift to which reference has been made. It is two miles long and a half mile wide. Its height is uniform with that of the rest of the

delta from which it has been cut off by a post-glacial ravine. Like many of the drift banks of the valley, it has suffered erosion on its riverward side.

Superimposed on the mass to the southeast, as was the case at Floyd, is an elongated mass of glacial material rising to 140 feet above the terrace with a northwest-southeast trend. The possibility of a composite origin is as applicable here as in the Floyd mass where subglacial streams, glacial lakes and rivers have undoubtedly played each its own role in the making of this feature. The 520-foot terrace marks the site of the Utica Airport.

Oriskany-Whitestown district. In the writer's opinion, this region, which Brigham (1898, p. 197) calls the Oriskany-Whitestown sand plain, contains the most interesting glacial features in the area because of its varied compositions, its composite nature and a representation of well-defined glaciofluvial types: a sand plain or delta, kames and an esker. In commenting on the Oriskany-Whitestown sand plain, Brigham (*ibid.*) says:

This is a noteworthy accumulation stretching between the towns named on the southwest border of the valley. The origin and relations are not clear. The main mass or "Oriskany bluffs" has an altitude of 540 feet. At Whitestown the altitude is 500 feet. On the valley side the slope is chiefly a product of erosion; on the west and southwest is a kame area, whose surfaces, in part, fall below and, in part, rise above the terrace, ranging between 480 and 600 feet. The mass lies at the mouth of the Oriskany creek, but both the surface expression and the internal structure appear to forbid the supposition that it is a delta related to that stream. Toward Oriskany an extensive opening at the base of the bluffs give a section of 30 feet. At the bottom are 15 feet of very coarse, much indurated gravel, with a profusion of cobblestones and small boulders. Above the gravel a fine, sandy silt is exposed to a thickness of 15 feet. This silt is seen in fresh excavations along the way to Utica continuously for nearly a mile. About midway of the mass is a nearly complete section from its base to the top. At its base is an exposure of 30 feet of fine sand alternating with beds of very fine silt, which holds moisture and "cuts like cheese." Except at the top, there is absolute freedom from gravelly material or even coarse sand. The beds incline slightly, but uniformly away from the valley. Above an unseen interval of 20 feet or more is a 45-foot section showing 15 feet of tumultuous coarse and bouldery gravel, at the top, and below, alternating sand and gravel with some cross-bedding. Its general inclination, however, as well as that of the silts below, is from one to three degrees southwest. A generalized section for the whole deposit, therefore, gives us a great body of fine silts intercalated between two massive bodies of glacial gravels. At Whitestown the coarse gravels are absent so far as seen. There is a slightly pebbly layer at the top, underlain by nearly 70 feet of very fine sand. Alternating thin layers are seen of finer or, at least, more coherent material, and with such regularity as to suggest a seasonal variation in deposition. The slopes here show evidence of ice contact and the water currents seem to have come from the north side of the beds. This fact and the inclination of the beds on the Oriskany bluff suggest a connection with the Nine Mile Creek delta, whose precise nature is, however, in doubt. The Oriskany beds are 20 feet higher than the edge of the delta. But for this fact, it would be reasonable to suppose that the delta deposits extended across the valley and have been breached by the river. Perhaps, the two masses mark different stages of recession.

The writer examined several sections of this sand plain, one at an old molding and building sand pit, worked for the first time in 1887. It is located on the south side of the sand plain and east side of the Whitestown-Colemans road, across from the Doyle farm at the curve in the road, and is as follows:

Top of sand plain	
Glacial till with boulders Southerly dipping stratified clayey sands	10 feet
Molding sand, thinning to south	5 feet
Gray medium-grained cross-bedded sand (building sand)	8 feet
Finer and coarser-grained gray sands below	

The Whitesboro sand pit, located at the east of Whitestown, at the time of this survey measured 300 feet by 250 feet by 25 feet. An east-west section is as follows:

Dark sandy humus	2 feet
Yellow unstratified till	3 feet
Stratified yellow sands with a westerly inclined bifurcated stratum of gravels. The stratification planes of the main sands continued on through the gravels, yet the gravel body was inclined to the west.	20 feet

In both of these sections there appears to be a till surface, indicating to the writer that there must have been a readvance of the ice but which body of ice, the Ontarian or the Mohawk lobe, it is not possible to state at this writing. The fact that this body of stratified sands is covered by glacial till is important and the only interpretation the writer sees in this occurrence is a readvance of some body of ice.

Colemans-Oriskany Creek kame area. In a gravel and sand pit measuring 100 feet by 50 feet by 30 feet, located just east of the Oriskany creek and one mile north of Colemans, is an interesting example of stratification, lithification and deformation. The section shows stratified, cross-bedded sands and gravels, the sands varying from 1 to 3 feet in thickness and the gravel beds from 4 and 5 inches to 4 and 5 feet. The deposit shows a general and gentle quaquaversal dip. A small keystone fault is developed in the mass

Figure 34 Kame terrace on east slope of Oriskany valley with preglacial channel in the foreground. (Photograph by N. C. Dale)

Figure 35 Kames along stream valley tributary to Oriskany creek, West hill, Deansboro, N. Y. (Photograph by N. C. Dale)

with a marked offset between the gravel and sand beds. In addition to this structural feature, there is a fracture cleavage developed. The quaquaversal attitude of these beds indicates kame structure while the keystone faulting and fracture cleavage would indicate either a postglacial earthquake-forming movement or deforming movement occasioned by the readvance of the ice. This bed was found to be closely associated with an esker which will be described shortly.

By pebble count the composition of the gravels was found to be 3 per cent igneous and 97 per cent sedimentary, with the Clinton formation representing 30 per cent and the Potsdam, Medina and Frankfort totaling 67 per cent of the sediments. The lithification of this deposit is to be accounted for through the cementation of the gravels by the carbonate of lime derived from the bicarbonate of lime in the circulating waters permeating the gravels of the drift.

Kames and kame terraces. A steep-sided knob or conical-like hill in a glaciated district, found to consist of stratified sands and gravels, is known as a kame and is generally associated with marginal moraines; but such features may be found with glacial moraines. On the Oriskany quadrangle kames are not as common as to the north on the Remsen quadrangle or to the south on the Sangerfield quadrangle, where they are so numerous as to constitute a kame moraine; they are more or less isolated features like Christmas knob at the foot of Elm street in Clinton, a conical hill 20 or more feet in height. They occur in considerable numbers at the west end of the major mass of the Oriskany-Whitestown sand plain where they rise 60 or more feet above the general level of the sand plain. Small aggregations of kames are likewise found south of Kirkland between the Clinton-Kirkland road and the Oriskany, northeast of Clinton near Mud creek, the Yahaundasis golf course in New Hartford and to the west along the Seneca turnpike. Those of the Whitestown-Oriskany sand plain and the Yahaundasis golf course are the highest, extending to 600 feet above sea level. Occasionally are found kettles, more or less irregular, bowl-like depressions with no surface outlet and due to melting of buried blocks of ice or knobs of poorly sorted material or till. Some of these depressions such as those southeast of Ridge Mills and northeast of Rome may be due to other causes.

Other kames or kame terraces were found along both slopes of the Oriskany valley, such as seen in figures 34 and 35. A kame nubbin, west and above the bridge along Bristol road crossing the Kirkland Ravine stream, gives the following section:

	Feet	Inches
Soil	1	..
Till of gravel and boulders—unstratified	2	..
Stratified gravels dipping steeply to east	..	9
Reddish brown medium-grained sand	1	..
Coarse sand	..	6
Medium-grained sand with reddish clay (derived from Vernon shale) Fine and medium-grained sand	1	..
Reddish massive clay dipping east	3	..
and slide clay	2	..
	11	3

This kame is apparently a part of a terrace over 50 feet wide and higher which separates the Kirkland stream and one to the south and according to the writer is typical of the Oriskany Valley kame terraces. The margin of the ice lobe occupying the Oriskany valley must have been crevassed and indented thus allowing for the deposition of the poorly sorted material which comprises them.

Esker. Associated with the Oriskany-Whitestown sand plain is a southwesterly trending serpentine ridge, known as an esker, located on the Doyle property between Colemans and Whitestown and extending from the kame area on the south side of the sand plain to a point a mile north of Colemans on the Colemans-Oriskany road (figure 36). The termination of this esker has already been alluded to in the description of the Colemans-Oriskany Creek kame section. This esker is nearly a mile long and takes the following trends, begining at the north end: S. 70° E., S. 20° E., S. 10° W., S. 70° W., S. 60° W., S. 80° E., E.-W., S. 30° W., E.-W., S. 55° E., S. 80° W., S. 75° W., S. 70° W., S. 25° W., S. 45° W. and S. 40° W. It is between 460 and 600 feet above sea level and its wooded crest rises and falls between these elevations but gradually flattens out to 460 and 480 feet and then rises to 500 feet at its terminus north of Colemans. It consists of fine-stratified and cross-bedded sands and gravels which show some small normal faulting as indicated by a two-inch throw. The deformation in this esker may be correlated with the keystone faulting in the Colemans-Oriskany Creek kame section so far as its origin is concerned, namely, pressure occasioned by a readvance of the ice at this point or earthquake-producing movement.

Aside from the deformation noted in this esker, there are other interesting points in connection with its history. An esker has long been regarded as having been formed in a tunnel at the base of the ice by a subglacial stream. According to Flint (1930, p. 105 and 108):

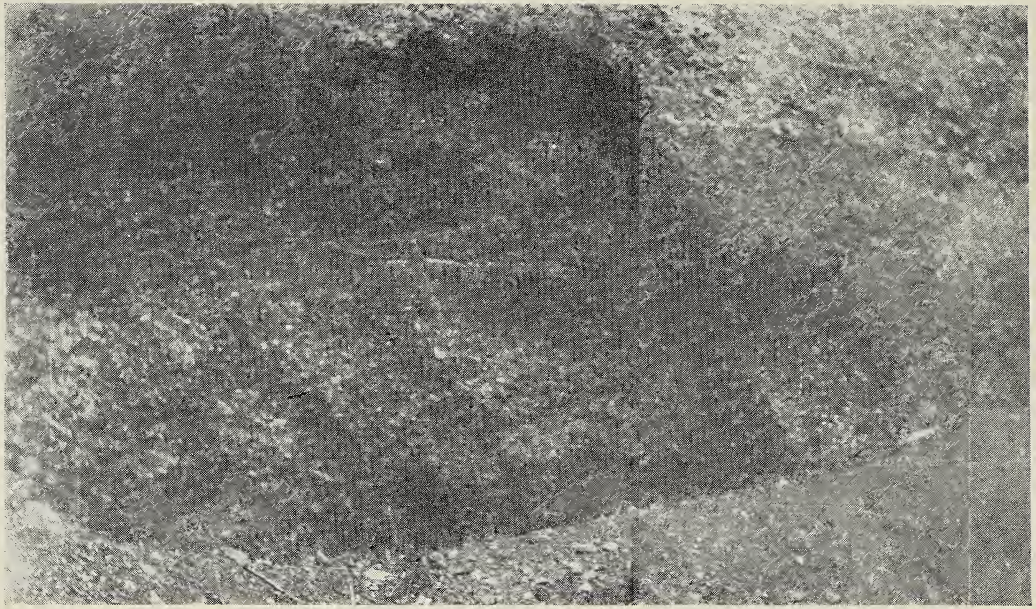


Figure 36 Section of Oriskany esker at Oriskany, N. Y. Cross-bedded zone is faulted several inches. (Photograph by N. C. Dale)

The chief objection to this theory in the minds of its critics has lain in the difficulty of explaining the double and reticulated ridges and broad pitted plains that are associated with eskers in most esker regions. Such features required "too broad an arch" to the tunnels in which they were supposed to have been dèposited. These objections disappear when the reticulated and pitted plain forms are viewed as (*a*) crevasse fillings, and (*b*) marginal lacustrine deposits. The esker tunnels merely helped feed or drain the lakes in which the latter forms were built up.

In this case, the Oriskany-Whitestown sand plain may be considered a marginal lacustrine deposit.

The serpentine trend of the esker suggests stagnation of the main mass of ice. If the glacier were an active one, the tendency would be that all parts of the esker which were not exactly parallel with the line of movement of the ice would be destroyed or distorted. Perhaps the faulting noted in this esker indicates the influence of ice movement of some sort, as has been suggested.

The marginal terrace otherwise known as the Oriskany-Whitestown sand plain carries its esker obliquely downward with respect to the top of the marginal terrace, the top of the kames and associated terrace being 560 feet above sea level and the southwestern end of the esker, north of Colemans, being 480-500 feet above sea level.

The structure of the Colemans-Oriskany Creek kame area shows it to be a quaquaversal faulted series of stratified sands and gravels.

Eskers may, according to Flint (*ibid.*, p. 109), "be regarded as criteria of stagnant ice. They are found only in regions where other evidence of dissipation *in situ* are abundant, ice-contact marginal terraces, great kettles, and an overwhelming preponderance of stratified drift." This region is undoubtedly one of marginal terrace and a preponderantly stratified drift area.

Oriskany-Sauquoit outwash plain. With stagnant or retreating lobes of ice occupying the Oriskany and Sauquoit valleys, small proglacial lakes must have formed to the south of the ice lobes in which lacustrine deposits were laid down. This disposition of the ice in these two valleys may have accounted for the gently sloping plainlike character of the valley floors as well as that of the stratified drift. Since its deposition, it has undoubtedly been reworked by the degrading and aggrading action of these two streams since the ice disappeared.

Thickness of the ice. How much thicker the ice over this region was than is indicated by the maximum relief in the vicinity of Utica can only be estimated by using a formula involving the difference in elevation between the height of the city and the height of the plateau, a matter of approximately 1600 feet and the distance from central New York into northern Pennsylvania, a matter of 125 miles. Using the above method for estimating thickness of ice for the lower Mohawk, Brigham arrived at " . . . a thickness of 5000 feet of ice above the present level of the Mohawk river at Utica. It must be remembered that this represents the earlier maximum flow across New York and antedated the Mohawk ice . . ." (1929, p. 42).

In considering the problem of glacial lakes in central New York, Brigham (1931, p. 129) says:

> No doubt there were many glacial lakes in this area but they were small and evanescent. All the sections opened over a period of many years show the conditions of typical kames. It seems necessary to believe from such evidence of the progress of the recession as we have that the Ontario ice was massive and active long after the Mohawk ice had mainly gone. Thus perhaps we double the demand which the Ontario ice makes on time. When the ice tongues in the Oriskany and the other valleys finally stagnated and melted away, they left many miles of ice-contact slopes in the several valleys. The ancient rock valleys were almost filled from side to side with aqueo-glacial waste and through the narrow and crooked lanes left between these steep slopes pass the streams and roadways of today.

To the knowledge of the writer, no evidence of deep waters in either the Oriskany valley or the Sauquoit valley has been found and such evidence would necessarily include terraces along the valley slopes above the present roadways at least. Along the 600-foot contour on the west side of the Oriskany valley and just south of College Hill road, recent cuttings at the road level exhibit sections of finely stratified and cross-bedded sands with thin beds of gravel (figure 37). Cross-bedding with northerly dips indicates that the flow was from the south along the side of the valley, if not for the entire width, to the 600-foot contour. Except for occasional patches of clay forming the banks of the Oriskany creek, which may be indicative of the work either of ice or of glacial lake waters; there being no varved clays in evidence at the locality studied, the Oriskany valley bears no visible evidences of a deep-water lake. The only topographic evidence of a shallow lake is the 600-foot terrace which appears occasionally on both sides of the valley, and this feature may very well be accounted for by one of the early phases of the obsequent Oriskany. The materials making up the floor of the valley appear to consist largely of worked over glaciofluvial deposits as shown in the various sections in the flood plain of the Oriskany as well as in the kames and deltas on the flood plain between Clinton and the mouth of the Oriskany at Oriskany.

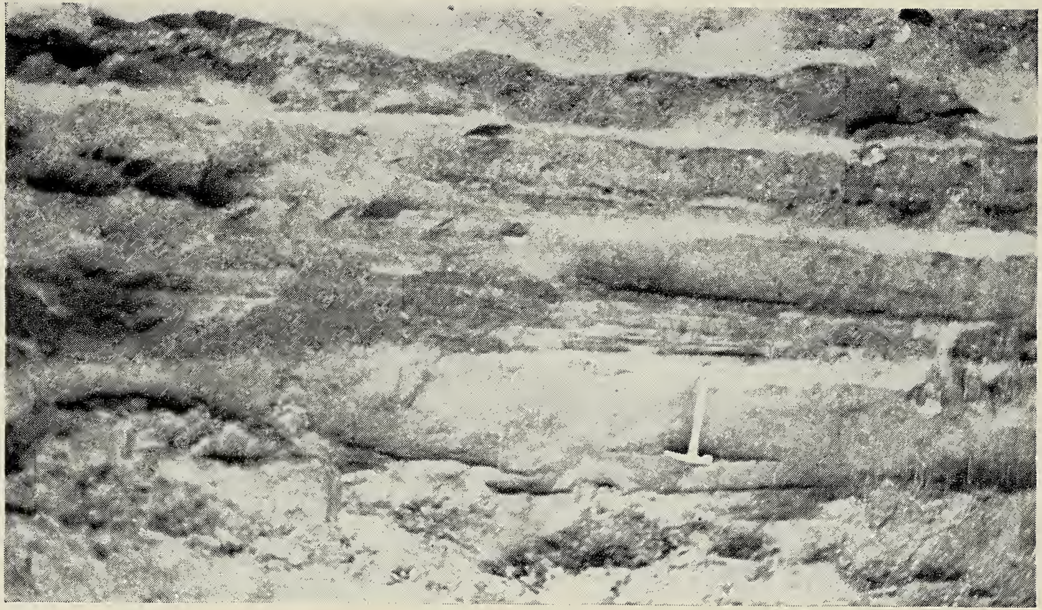


Figure 37 Section of 600-foot terrace in Oriskany valley, south of College street, Clinton, N. Y. (Photograph by N. C. Dale)

The Rome area. The present divide between the Mohawk-Hudson and the Ontario-St Lawrence river systems passes in part through the city of Rome at the north between the south-flowing Mohawk and Wood creek. Chamberlain and Brigham long ago observed that the preglacial divide was at Little Falls but, due to local cutting resulting in the coalescence of the east and west-flowing streams at or near Little Falls, the divide was shifted to the Rome area. It was believed that this migration of the divide was due doubtless to the escape of hyper-Iroquois waters from the Ontario ice lobes during the life histories of the proglacial Lakes Dana (elevation 700 feet), Dawson (elevation 480 feet) and Iroquois (elevation 440-60 feet). It was during Lake Dawson times that the Niagara cataract and Lake Erie were initiated. According to Fairchild (1909, p. 57), outlets from Lake Vanuxem at Syracuse at the 900-foot level in two stages, however, caused an earlier outlet at Rome toward the east. The constructive effect of these voluminous waters flowing east from the Rome district is well exemplified in the several large sand and gravel pits north and northwest of Rome, which have long been operated for constructional purposes. Their stratified nature, scour and fill, cross-bedded nature, and rapid changes in sedimentation all testify to the nature of the mechanical load of the waters originating within the Ontarian ice lobe. For further description of these deposits the reader is referred to the chapter on economic geology, page 184. If these pits are at all representative of the remaining unexcavated part of the level expanses surrounding the city of Rome, it is a fair presumption that Lakes Vanuxem, Dana, Dawson and Iroquois, as well as the hyper-Iroquois and early Mohawk, may have all been contributory factors in the development of this nearly level expanse in the Rome area.

Diverted river courses. Three streams in the Oriskany area have suffered diversion, two of which, the Oriskany and the Sauquoit, are still active in the immediate region. The third, the West Canada creek, which is outside the area, though originally flowing into the Mohawk at Holland Patent, is now meeting it at Herkimer.

The former course of West Canada creek as seen on the Remsen quadrangle from Prospect to the Mohawk was by way of Nine Mile creek. The present width of the valley of Nine Mile creek, as well as the volume of glaciofluvial deposits in this valley and at its preglacial mouth north of Oriskany, strongly suggests such a course. This diversion was undoubtedly brought about by large deposits of glaciofluvial material near Prospect causing the preglacial West Canada creek to pursue a shorter and rougher route to the south and southeast, thus creating for itself the beautiful gorges and waterfalls near Trenton Falls.

On the Oriskany quadrangle the Oriskany creek during its postglacial life has undoubtedly been diverted from its course on its inherited flood plain. There are two possible sites of diversion, one offering much stronger evidence than the other. At Farmers Mills, two miles south of Clinton, the Oriskany is flowing in a restricted channel with small rapids in the Lockport horizon between the 660 and 700-foot contours. This small gorge is cut through the Vernon and Lockport thus separating an outlier of these formations from the main formations on the east. A valley one-half mile wide occurs to the west of the outlier and carries the old Chenango canal which appears to have been able to accommodate the former Oriskany before the gorge was cut. Such a diversion as has been implied may very well have been brought about by ice-blocking somewhere to the south of the gorge. As no sizable morainal deposits occur to the south, such blocking could have been occasioned by an ice tongue or stagnant block of ice during the last stages of ice retreat in this valley. Whether or not this 80-foot deep gorge was cut entirely in postglacial times can not be satisfactorily proved, but this much is certain, that the greater ancestral Oriskany must have used the greater or wider valley to the west in postglacial times when the valley was filled with the melt-waters of the retreating ice. The Oriskany, when swollen by melt-waters, may not have flowed entirely along its present course through Kirkland and Oriskany to the Mohawk, but may have followed along the low area occupied by Mud and Sauquoit creeks. The site of the abandoned Chenango canal between Capron and Utica as well as evidence gained from drillings in the Utica area warrants the selection of this course as that of either the Oriskany or the Sauquoit.

RECENT

Aside from a gradual uplift of this region due to the disappearance of the ice sheet and occasional fault movements, there have been no great movements which might accelerate the erosional processes. Since the ice sheet has disappeared, however, erosion in the last 20 thousand to 25 thousand years has manifested itself both destructively and constructively. Undoubtedly the most important destructive effects were accomplished when the waters from the great lakes were flowing through the Mohawk. The potholes at Telequaga park east of Little Falls testify to the fact that the stream must have been at least 50 feet above the present Mohawk. The main tributaries of the Mohawk in our area must also have been considerably enlarged, as shown by the 600-foot terrace in the Oriskany valley, and the depth from this terrace to the present flood plain of the Oriskany, which is less than 50 feet, should represent the work of the Oriskany since the ice left these parts. Many of the shorter tributaries of the Mohawk system started to develop after the ice left this region, because they not only cut through the drift, but also into the underlying formations, as shown by the sections along the banks. The heterogeneous glacial boulders in the stream beds are evidence also of the effect of sorting action of the stream and gravity upon the boulder-filled drift which the postglacial streams inherited. In addition to the extended development of the drainage system both laterally and vertically, there has been also a general reduction of the cuesta and lowland as well as considerable aggradation, but how much has never been ascertained.

Some changes, the development of canals among them, have been wrought by man in his brief possession of the region as he has tried to cultivate and industrialize the more favorable parts. Deforestation has been responsible to a certain extent for acceleration of erosion, but cultivation has for the most part checked this tendency.

ECONOMIC GEOLOGY

The natural resources of the Oriskany quadrangle are its iron ore, natural gas, building stone, road metal, brick-making clays, mineral waters and soils. Of these the natural gas is of little economic importance.

IRON ORE

History of the Iron Industry

The iron industry in this area was begun in 1797, shortly after the first lease for the digging of iron ore was let on what became known as the Norton mine on the Rogers estate on Bristol road, just half a mile north of College street in the village of Clinton, where the dumps of the old stripping operations can still be seen. This mine is located west of the village of Clinton, in the township of Kirkland. Were we to include the present extraction of hematite for the manufacture of paint, the industry has been in operation for approximately 143 years. The Clinton Metallic Paint Company sank its Brimfield mine shaft in 1928. For 120 years the ore was used largely for pig iron made in the local furnaces, but later, by a few years, prior to World War I, the ore was shipped to the furnaces in Pennsylvania for the manufacture of steel (Gridley, 1874, p. 70).

The excavations found in the hematite and red flux zones of the Clinton formation in this area mark the sites of the earliest mining of the Clinton hematite in the eastern part of New York State. The ore came largely from open mines on the outcrops at Washington Mills and Chadwicks in the town of New Hartford, east of Clinton, in the Sauquoit valley which were known as the East Hills Ore Mines. In the Oriskany valley, the ore was mined largely in the towns of Kirkland and Westmoreland, principally in the villages of Clinton, Kirkland, Lairdsville and Hecla Works.

The discovery in the town of Kirkland was due to the ore being turned up in plowing on the farm of John D. Stebbins, south of Stebbins creek which stream flowed presumably through his farm and later was named after him. Patrick, the plowman, little knew that he had uncovered the most useful of all minerals. Many openings have been made in the ore at intervals all the way from the Oneida-Herkimer county line on the East to Verona Station on the West (*ref. cit.*, p. 170).

The first furnace was constructed in Westmoreland in 1800 for handling the ores from that vicinity. "It is a little remarkable," says John E. Elliot, before the Clinton Rural Art Society in December 1864, "that the Hecla Furnace Company drew a large part of their ore from the town of Kirkland, a distance of six miles, driving their teams over an undiscovered bed of ore lying near the surface within one mile of their own works, and with an abundance of it in the immediate vicinity." The Westmoreland blast furnace was erected in the southwest part of the town, known today as the Hecla Works, for the treatment of the ore mined from near-by localities, even as far away as Verona. The enterprise, however, did not last long, the old foundry being later converted into a saw and grist mill.

Not until 1852 did mining flourish in this vicinity, when the Franklin Iron Works constructed furnaces at Kirkland and Franklin for the conversion of the ores mined near by into pig iron. A new stack, 55 feet high and 14 feet in diameter at the base, was constructed in 1869-70, with a capacity of 100 tons of iron a week, using about 350 tons of ore and 240 tons of coal for the same. This furnace continued operations until 1890-92.

Quality of the Iron Ore

According to Professor Chester (1881, p. 2-6):

The furnaces at both these works have, at times, been run on this ore alone and have produced a good quality of iron. The average of a large number of analyses of the Clinton ore shows it to have the following composition:

Silica	13.09
Iron, metallic	44.40
Alumina	5.99

Manganese oxide	0.19
Lime	5.85
Magnesia	2.69
Sulphur	0.31
Phosphorus	0.53
Carbonic acid	6.08
Moisture	1.45
Oxygen, with iron and phosphorous	19.71
	100.29

The above analysis shows 44.40 per cent of iron. It is quite safe, therefore, to call it a forty per cent ore, and to claim that two and one-half tons of it will afford a ton of iron. In a long run of the Franklin furnaces, the average for the Clinton ore was two and a quarter tons to the ton of iron made, showing the ore to be about 44 per cent iron.

At Manchester, a blast furnace was erected a few years ago, the ore supply to come from these Westmoreland beds. The charge now in use there is said to be two-thirds Clinton ore and one-third Port Henry ore. It is also largely shipped to other furnaces. An average sample of the Westmoreland beds, according to the analysis, was quite similar to that of Kirkland and New Hartford and the best ore from all these sections is much the same in character. The phosphorous averaged in all the beds about six-tenths of one per cent.

Even at that time, the "red flux" was considered too lean an ore to be worked with a profit, having only from 10 to 20 per cent of iron. Since it had 40 to 55 per cent of carbonate of lime, it was used in the furnaces for fluxing the better ore, but it was not suitable for this purpose since the percentage of lime was variable even in the same bed, and if used in a furnace, constant analyses would be necessary to keep the right proportion between ore and flux to make a good slag.

Good fluxing limestone was found above the valley in the Manlius formation. A quarry on the hill top southwest of the Franklin Iron Works at Franklin undoubtedly supplied their furnace (figure 30).

Pennsylvania coke at $5.50 a ton was regularly used at the two furnaces. Charcoal furnaces and forges were used earlier for the treatment of the Clinton ore.

Much of the ore in the early days went to the furnaces in Poughkeepsie and elsewhere by canal and railroad, and after the local furnaces ceased operations, much more was shipped away until about the time of the first World War. The mines belonging to the Franklin Iron Manufacturing Co. of Syracuse, and C. A. Borst of Clinton were the most active, but during the postwar period up until the present time, the Clinton Metallic Paint Company has been the only producer.

Mining Operations

In his account of the methods of mining in Oneida county, Newland (1910, p. 173) says:

> The method of stripping, once used exclusively, has now given way to underground mining. The advancing long-wall system is employed in both mines at Clinton, and it seems to be well adapted to the conditions there, as well as in other parts of the Clinton belt. By taking advantage of the surface-features, it has been possible at Clinton to follow the ore from the outcrop, and to use the slight inclination of the beds to secure natural drainage. The main entries or gangways are run in an easterly or northeasterly direction across the dip. From these, branches turn off as every 100 feet to working face. The ore measures 30 inches on the average, and about two feet of the overlying shale is taken down to afford working room. The shale is packed behind the face and the roof further secured by placing wooden posts temporarily in front of the pack. The posts are removed, so far as possible, after the roof is supported, to be used again in the same manner. Owing to the soft character of the overlying beds, the roof settles readily and uniformly, with little or no danger from the falls. The lower part of the ore seam is removed first by drilling a line of holes diagonally from near the top. After these are blasted, the upper part with two feet of the shale is taken out by drilling horizontal holes. The ore is trammed by hand or mules to the loading stations outside. Figure 38 illustrates this method.

Further details of mining methods are given by Newland and Hartnagel (1908, p. 61). Later on the ore was trammed by gasoline engines.

Ore Reserves

As no information as to thickness of the ore is available except in natural exposures and in the stripped and mined areas, any figure as to the amount of reserves in this area can only be of the most general nature. Such a figure has been obtained by dividing the area well below the 1500-foot contour into measurable units. It was found that there are much more than 20 thousand acres under which the Clinton ore must exist, so with a thickness of ore of either 18 inches or two feet, we should expect between 120 million and 150 million tons of ore on the basis of 6000 to 8000 tons to the acre. Not until the area has been thoroughly drilled can we hope to arrive at any reliable estimate of the reserves of iron ore in this region. As a matter of fact we should have to employ the general formula where the following factors should be known:

Length of outcrop
Average thickness of ore seam at outcrop

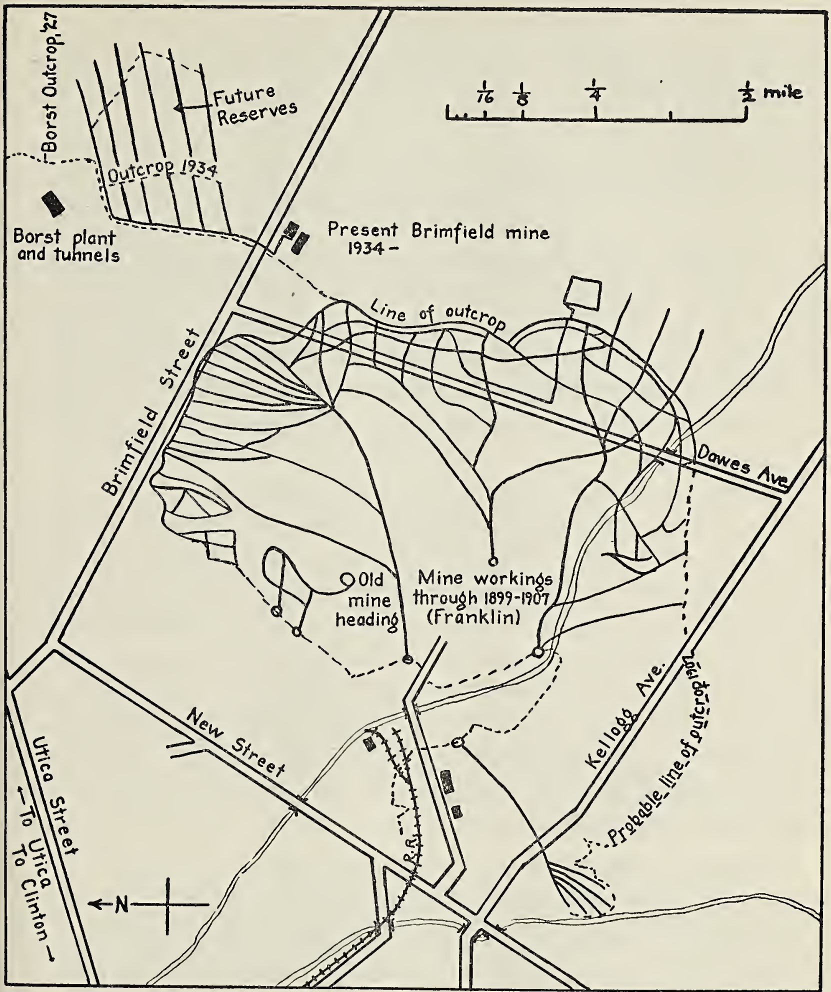


Figure 38 Plan of long wall mining at the Clinton hematite mines. A composite map sketched from property and working maps provided through the courtesy of the Clinton Metallic Paint Co. Stripping operations carried on entirely prior to 1897 are omitted, but followed the 700-foot contour in general; openings being made between New Hartford in the Sauquoit valley and at Clinton, Kirkland, Lairdsville and Hecla Works. (See Geologic Map)

Minimum thickness to which the ore may be worked
Maximum distance from the outcrop practicable to mine the ore
Percentage of recoverable ore

The other factors, including the average percentage of metallic iron and specific gravity of the ore based on the value of the iron, are easily obtainable. The total tonnage in long tons is then obtained from the formula: volume × specific gravity × weight of a cubic foot of water divided by 2240 pounds.

Occurrence of the Iron Ore

In the stratigraphic column the iron ore holds a position in the lower member of the Niagaran series, the Clinton beds (see table, p. 21 and 24).

Except for the interruption occasioned by the Salinan series, the Silurian formations exhibit a transgressive condition of marine sedimentation, starting at the base with shore deposits of conglomerates and sandstones, then passing through deposits indicating shallow-water marine conditions of a somewhat oscillating character, as typified by the Clinton and Lockport formations in which shales predominate over calcareous and dolomitic zones. Ripple and channel marks, accompanied by invertebrate tracks and marine vegetation, testify to shallow water conditions for deposition of much of the Clinton rocks.

From sections given elsewhere (page 39), it will readily be seen that the Clinton ore occurs as regular sedimentary strata associated with other strata in a conformable series. The contact of the ore with the overlying and underlying strata is sharp. This concordant relationship of the hematite beds with the strata immediately above and below, an outstanding feature in all the sections, and the partings within the ore, all point to contemporaneity of deposition, a fact which has long been known and described by former students of the Clinton. Microphotographs of the oölitic hematite show some disseminations of the oölites beyond the contact, but even so the contacts are remarkably sharp.

Primary Nature of the Oölites and the "Red Flux"

We have already noted that the hematite of the Clinton is the most important iron-bearing mineral and that the chamosite, pyrite and siderite are minor minerals in certain zones not intimately or directly associated with the oölitic and "red flux" hematites, though these three minerals do occur within fairly close association in the upper part of the Willowvale or what is referred to as the "lean ore zone" (figure 12*b*). It has also been demonstrated that the iron deposits are primary sedimentary deposits of mechanico-chemical origin, the iron having been deposited as a chemical precipitate in the lagoonal parts of the Clinton sea from solutions derived from dissolved iron-bearing minerals originating in the Precambrian and overlapping and fringing lower Paleozoic rocks surrounding the northern and eastern parts of the basins.

Hayes (1915, p. 79) in his thorough work on the Wabana ores described the physical process involved in the formation of oölites as follows:

The experimental formation of finely laminated concretions about a nucleus of sand or calcium sulphate is especially interesting and suggestive. By means of bacteria organic matter is decomposed and ammonia is set free to form ammonium carbonate with the dissolved carbon dioxide in the water. The calcium sulphate is usually precipitated as a very finely divided powder and it seems probable that this material gathered about the nuclei by the force of surface tension rather than by the aid of organisms.

Wieland (in Twenhofel, 1932) suggests that the oölites were due to the alternate precipitation of silica and hematite about nuclei. This structure was suggested by the fact that when the iron oxide is dissolved concentric tests of silica remain, an investigation which Smyth successfully undertook long ago. In this opinion, the writer concurs.

Mathews (1930, p. 642) claims that:

The great Salt Lake oölites originate at the water's edge where they are washed upon the mud flats and grow as they are driven overland by the wind. The laminae correspond to the seasons and result from the direct precipitation of amorphous aragonite from evaporation of capillary water. Growth takes place during early summer when the rise of temperature of evaporation is greatest. Little, if any, growth occurs in the water. The oölites on the bottom of the lake are small with only one or two laminae. The accumulation of soot on the exteriors of the crystalline laminae of the oölites is considered proof that the formation took place on land and that each band of soot was collected during the rainy season. Most oölites formed around some solid nucleus and of 574 examined, only four were found that might have formed around a gas bubble or an alga.

No information is at hand regarding the depths at which oölites may form other than what has been observed at the Great Salt Lake occurrence except that at both the Wabana and the Clinton deposits the oölites are of decidedly shallow water origin. Moreover, it would appear that the oölites were in all probability rolled about by ocean currents though their sphericity is due in part to the initial shape of the nucleus, generally a rounded sand grain, in part to surface tension and also, to wave or current action.

Twenhofel (1932, p. 769) does not consider "that the facts warrant the sweeping assumption that oölitic and pisolite formation require materials to be in the form of a colloid before they can participate in such formation. It seems probable that all the material can be in a true solution. The 'shot' in laterites and pisolites in bauxite show that a water cover is not required. The writer considers it reasonable to assume that no generalization relating to oölite and pisolite formation has universal application."

Conditions for the formation of the "red flux" did not differ fundamentally from those under which the oölitic variety of iron ore formed except for the preponderance of organic material in the form of bryozoans and more carbonate minerals.

Siderite and Its Relation to Other Iron Minerals

Due to the inability on the part of the writer to identify the siderite precisely in all the thin sections, no conclusions were reached regarding the definite relationship with the hematite, chamosite or pyrite. The violent effervescence of the carbonate groundmass of both the oölitic and red flux zones indicated a predominantly calcareous composition for those zones. The euhedral shape, the ash gray color and polysthenetic twinning of the carbonate material, however, indicated the presence of siderite in the lean zone, but close relationship between the oölitic hematite, pyrite or chamosite did not seem to be apparent. Conspicuous twinned anhedral grains with rhombohedral subindividuals in the oölitic zone would indicate either dolomite or siderite. In point of time it would appear that the carbonate material crystallized at a later time than the amorphous hematite whereas the red crystalline hematite or goethite (?) was later than the carbonate in the nuclei of the oölites.

Mineral Paint

The only important use of the hematite at present at Clinton is in the manufacture of pigment. The ore is mined at Brimfield mine, one-half of a mile southeast of the old Borst mine off Brimfield street (see figure 38). The thickness of the ore is two feet. The ore is taken from a 50-foot shaft at the mine and transported to the paint mills at Franklin Springs where the process comprises the following steps: The ore is crushed after it is conveyed to heaters which dry off all mechanically combined moisture and volatile matter and, in a red hot condition, it is conveyed to the hammers where the material is ground against iron meshes with one-quarter inch holes. The ground material then passes on to the millstone stage where the hematite is completely pulverized, the ground hematite being finally blown into the bagging chute. The powdered hematite which is used in coloring mortar or bricks and mixed with oil, serves as an excellent red paint. It is also used in coloring cement floors.

NATURAL GAS

Natural gas has long been known in New York State (particularly in Erie, Oneida, Onondaga, Ontario, Oswego and Jefferson counties) but except for the Pulaski and Sandy Creek areas in Oswego county, little production is encountered in the Trenton limestones. In the Oriskany area gas occurs in connection with the Halleck Saline Mineral Spring at Westmoreland and at the Clinton Lithia Springs. In the former it arises from the Frankfort shale, and in the latter it apparently comes from the Clinton. Aside from these seepages it is found directly associated with wells drilled in the Trenton for gas.

Rome Wells

The first well in Rome was drilled by the Rome Factory and Building Co. north of the Mohawk river to a depth of 832 feet. Gas was found at 216 feet in the Utica shale and 690 and 832 feet in the Trenton or 55 feet and 187 feet from the top of the Trenton. This well is estimated to have yielded about 200,000 cubic feet of gas per day for about two weeks and then the quantity began to decrease (Prosser, 1900, p. 145).

The second Rome well was drilled to a depth of 1632 feet into the Precambrian by the Rome Brass and Copper Company and was located near the level of the New York Central Railroad tracks and the Mohawk river.

Prosser's geologic section based on log of second Rome well

FORMATION	DEPTH From To	THICKNESS
Drift	0– 125 feet	125 feet
Hudson shale	125– 350 feet	225 feet
Utica shale	350– 650 feet	300 feet
Trenton limestone	650–1025 feet	375 feet
"Birdseye" limestone	1025–1085 feet	60 feet
"Calciferous"	1085–1560 feet	475 feet
Precambrian	1560–1632 feet	72 feet
		1632 feet

Natural gas in this well was obtained at 665 feet, or 15 feet below the top of the Trenton and at 860 feet or 210 feet below the top of this limestone. Seven to eight million cubic feet of gas came from this well in the first 24 hours, but later it decreased to 75,000 cubic feet in 1897 (Prosser, 1900, p. 143-44).

Since this early date many wells in the vicinity of Rome have been drilled, principally during the years of 1935 and 1936, the location of which may be seen on the geologic map.

Ringdahl Wells

These wells, four in number, were located from one-half to one mile south of Ridge Mills, east of Rome and on the west bank of the Mohawk river. The gas from these wells was metered and used by the Ringdahls in their greenhouses which the writer visited during the period when the gas was being used. Some 12 million cubic feet of gas was metered from these wells from June to December of 1937; but it was understood by those not connected with the organization which did the drilling, that most of the gas was taken from one of the wells. The wells were arranged quadrilaterally on an 88-acre plot.

Murphy Well

This well was completed and drilled by the Natural Gas Products Co. of Rome, N. Y. It is located on the east bank of the Mohawk and northeast of the Ringdahl wells. The log is as follow:

Drift	0- 20 feet
Frankfort shale	20-150 feet
Utica shale	150-430 feet
Trenton limestone	430-746 feet

Gas occurred at the 482, 470, 495, 605, 615, 625 and 633-foot levels, increasing toward the bottom. Rock pressures of 140 pounds per square inch and an open flow of approximately 500,000 cubic feet were reported. The writer assisted in the measurement of these pressures.

Ankin Well

This well is located one mile north of the city limits of Rome. The log is as follows:

Drift	0– 21 feet
Frankfort shale	21– 40 feet
Limestone	40– 60 feet
Frankfort shale	60– 75 feet
Limestone	75–135 feet
Frankfort shale	135–200 feet
Utica shale	200–548 feet
Trenton limestone (with salt water at the 787-foot level)	548–787 feet

Gas was noted at the 548, 556, 560, 571, 573, 721 and 787-foot levels with salt water at the bottom which spouted to the top of the derrick. The well was later abandoned.

Several wells just north of the Oriskany quadrangle were drilled at about the same time as the ones just described and are at this time worthy of consideration.

Eddy Well

The log of this well is as follows:

Drift	0– 43 feet
Gray limestone	43–150 feet
Frankfort shale	150–245 feet
Utica shale	245–505 feet
Trenton limestone	505–622 feet
Sandy limestone	622–889 feet

This well had very little gas.

Hooper Well

This well is located at Ridge Mills on the Hooper farm and owned by William Jones. A rock pressure of 150 pounds was reported.

Hathaway Well

This well is located on the Hathaway farm three miles south of Stokes and two miles north of Rome. At the time of the writer's survey it was being used in furnishing heat for pasteurizing milk. The log is as follows:

Drift	0– 83 feet
Frankfort shale	83–230 feet
Utica shale	230–595 feet
Trenton limestone	595–895 feet

Gas occurred at the 649, 661, 738, 810, 825 (best) and 895-foot levels. Rock pressure of 90 pounds per square inch and an open flow of 281,508 cubic feet to 302,770 cubic feet were recorded.

Occurrence of the Gas

From studies of the Trenton limestone at Deer river, east of Carthage in Mill creek, west of Lowville and northeast of the Tug Hill gas field, along Big brook, east of Frenchville and along West Canada creek at Trenton Falls, all outside of our area has been found to be essentially a thin-bedded bluish gray rock of impalpable to subcrystalline texture with dark carbonaceous shale partings. The strata dip 40 or 50 feet to the mile to the southwest with occasional departures from this regional dip due to some local folding or faulting, such as seen in the town quarry, east of Holland Patent. In the present drilled area of our sheet, there are no exposures of the Trenton. So far as can be determined, the accumulation of gas is under no structural control; and as the Trenton limestone is found to be the reservoir for the gas, it is essential to determine, if possible, where and why the gas finds storage in this formation. Because of the impalpable and subcrystalline texture of the limestone, it is obvious that the rock, in itself, as a possible reservoir, must be eliminated, so that the only possible places of accumulation for the gas would be the solution cavities along the joints and bedding planes or the shale partings. The Trenton limestone of central New York, unlike the dolomitic limestone of the Ohio field, is a very pure limestone and hence has no solution cavities due to shrinkage like those found in the dolomitic limestone in the Ohio field. We should expect, of course, solution cavities along joints, bedding and fault planes, but whether such features offer other than a local control for the accumulation of gas, we have no knowledge. In the Baldwinsville field of Onondaga county, to the west, the gas in the Trenton occurs in two distinct horizons, evidently fossil coral reefs. Coral reefs in the Trenton of Oneida county are rare, if found at all in this area, so that it would appear that the only possible places for the accumulation of gas would be the shale partings or breaks as proved in the Pulaski and Sandy Creek field of Oswego county. In confirmation of such occurrence is the relative scarcity of absolutely dry holes in this area.

Source and Accumulation of the Gas

So far as the ultimate source bed of the gas is concerned, there is little precise information, yet we suspect that the abundance of organic matter in the Trenton limestone and the highly carbonaceous character of the shale zones might have furnished the materials from which the gas was derived. From the only available local places of accumulation such as the divisional planes referred to above and the more general places of accumulation, as noted in the shale partings, the gas did not have far to migrate and hence, accumulated in these near-by favorable places. The thicker and more abundant these shale strata were, the greater was the accumulation of gas.

Gas-Producing Zones

From the logs of the wells drilled in this area we learn the thickness of the Trenton in the various parts of the area. The thickness of the Trenton penetrated at the Hathaway well, two miles north of Rome and just off the Oriskany sheet, is 300 feet, with gas at 647 feet, 661 feet, 738 feet, 788 feet, 810 feet, 825 feet and 895 feet, with the best gas at 825 feet, 70 feet above the bottom of the well. In the Murphy well, 635 feet deep, the gas increased towards the bottom or 833 feet, but gas was found at 482 feet, 490 feet, 495 feet, 605 feet, 615 feet, 625 feet and 633 feet in 316 feet of Trenton. In the Ankin well which is 787 feet deep, gas was noted at

548 feet, 556 feet, 560 feet, 571 feet, 573 feet, 721 feet and 787 feet, with salt water and gas at 787 feet.

In the Eddy well one mile northeast of the Ankin well and two miles northeast of Rome, only 117 feet of Trenton was definitely identified from depths of 502 to 622 feet. Below this the drill encountered 267 feet of sandy limestone. It is possible that the sandy limestone belonged in the Trenton, in which case there would be 384 feet of Trenton. Salt water was encountered at 270 feet and cased off at 289 feet. No important gas was encountered in this well. The thickness of the Trenton to be found in this drilled area ranges from 316 to 330 feet, but 350 feet were recorded at the Campbell well in Whitesboro, drilled for water in 1887.

The section of the Campbell well is as follows (Prosser, 1900, p. 101):

Depths Feet	*Thickness Feet*	*Formation*
..	90	Lorraine shale of the Hudson River group
90	710	Utica shale
800	350	Trenton limestone
1150	180	Gap of 180 feet between Trenton and calciferous, 100 feet of which probably belongs to the calciferous, which would make the top of the calciferous at about 1230 feet
1330	260	Calciferous and arenaceous strata
1590	410	Calciferous and arenaceous strata
2000	100	Potsdam
2100	..	Precambrian

In the recently drilled Sangerfield and North Brookville areas where some five wells were put down, the Letts No. 2 well encountered at least 326 feet of Trenton limestone, between the depths of 3286 and 3612 feet. It would then appear that under the Oriskany area, not only does the Trenton limestone occur, but it exists at progressively deeper horizons from north to south, approximately between 300 and 410 feet thick.

From the various occurrences of gas in the vicinity of Rome, it seems reasonable to expect natural gas in the other parts of the Oriskany area; but not until a systematic prospecting, particularly along structural uplifts as the Oneida monocline or along the Lairdsville faulted area, would we expect to find any unusual amounts of gas.

In the Rome area, pressures of 90 to 147 pounds a square inch and open flows ranging from 290,000 to 350,000 cubic feet in the more recently drilled wells were recorded, while for the second Rome well, Prosser (1900, p. 144) reports as follows:

Natural gas was obtained at 665 feet, 15 feet below the top of the Trenton, at 860 feet, 210 feet below the top of the limestone. The lower horizon was the principal one, where a pocket of gas was struck which yielded, according to Mr J. S. Haselton, secretary of the Company, between 7 and 8 million cubic feet of gas in the first 24 hours. At the end of the first week, the yield had decreased to 600,000 cubic feet and on September 1st, 1897, it was estimated at 75,000 cubic feet.

Quality of the Gas

The natural gas of this area is presumably like that of the Baldwinsville area (Orton, 1899, p. 468) of Onondaga county, which is in the same Trenton horizon. It was almost pure methane and dry.

Composition of Baldwinsville gas

	Per cent
Methane (CH_4)	98.40
Carbon monoxide (CO)	.95
Illuminants diffused	.25
Hydrogen (H) (Paladium method)	Trace
Oxygen (O)	Trace
Acetylene (C_2H_2)	.00
Carbon dioxide (CO_2)	.00
Nitrogen (diff.)	.40
Total	100.00

Specific Gravity	.558
B.T.U. (Heat units)	1013.5 cu. ft.
Odor	faintly sweet

No petroleum has been found in this part of New York State although the existence of good reservoir and cap rocks and their occurrence along on old shore line are generally considered favorable criterions. Failure to find it may be due to evaporation in ages past. It is quite possible that an additional reason for its nonexistence is the lack of abundance of proper source rocks. Many tests with the Utica shale and carbon tetrachloride fail to show the presence of kerogen.

BUILDING STONE

The Herkimer sandstone of the Upper Clinton and the Manlius limestones are the main sources for the building stones on this quadrangle. The former has been used almost entirely for the construction of some of the buildings in the village of Clinton and for most of the buildings of Hamilton College, while the Manlius limestone was used in some buildings in Utica. Manlius was used largely for flux in the days of the blast furnace of Franklin Springs and now largely for road metal.

Dawes Quarries

These quarries opened in the upper Clinton or Herkimer sandstone are located north of Dawes creek and Kellogg street just east of the village of Clinton in the town of Kirkland. The larger and older of the excavations, measuring 200 feet by 50 feet with a face of 41½ feet, has furnished the stone for many of the buildings of Hamilton College. The newer and smaller excavation, a few hundred feet north of the older and larger one, is the one from which the rock for the present gymnasium of the college has been taken. The quarry on the west side of the valley on the site of the swimming pool of the C. B. Rogers estate is believed to have furnished the material for the First Presbyterian Church of Clinton.

The rock is a pyrite-bearing sandy dolomite (figure 13*b*). The beds composing it measure from one inch to 20 inches in thickness, but the greater part of the formation contains strata three or four inches thick. The joint planes which trend N. 75° W. and N. 10° W. aid not only in the excavation but also in the shaping of the blocks for construction purposes. After two years of exposure to the climate of central New York, the color of the rock in the buildings changes to a brown, a feature due entirely to hydration and oxidation of the disseminated pyrite, causing the diffusion of the iron-bearing solutions throughout the rock around the pyrite centers and a precipitation of the protoxide of iron or limonite. Some of the diffused solution emanating from the disseminated pyrite may be in the form of a sulfate, which later on becomes altered to the limonite through oxidation. The effect of pyrite on this rock is very pleasing as shown by the uniformity of coloring due to alteration of much disseminated pyrite to limonite. The administration building at Hamilton College originally built in 1812, and showing no particular signs of deterioration, attests to the durability of the rock.

Cittadino Quarry

This quarry, owned by Frank Cittadino of Utica, consists of Manlius limestone and the lower part of the Coeymans and is located half a mile west of Paris. The rock is used both for building stone and road metal, though the latter is the main use. There are two openings, the lower and larger one measuring 300 by 150 by 38 feet, and an upper one of less extent measuring about 24 feet in height. The rock used for building stone comes from a four to ten-foot zone of blue limestone from which blocks measuring ten by six inches are in demand.

ROAD METAL

There are a number of openings for road metal in this area both in the Manlius and the underlying Bertie waterlime. The Cittadino quarry described above fulfills the state specifications for road metal and good standard screened products such as No. 1, No. 2 and No. 3 grits are produced.

The equipment of this quarry consists of two small steam shovels, one large and one small crusher and one sizing cylinder. Joint planes trending N. 15° E., N. 65° E. and N. 9° W. have aided in the excavation and processing. The demands for this stone come largely from the Utica market.

The other openings in the Manlius are the Lawless, Kirkland and the Eisler quarries some two miles south of Prospect hill. The Lawless quarry, one and one-half miles south of Prospect hill and the Kirkland quarry in the same vicinity have all supplied local needs in times past and are no longer active. The Lawless quarry is believed to have furnished the limestone for the flux in the blast furnaces of Franklin Springs in the heyday of the iron industry.

Three quarries in the Bertie waterlime are found on this sheet, two on Prospect hill and one on Crow hill. Of the two on Prospect hill, the one on the west side belongs to the Elihu Root estate; and the other, on the east side, belongs to the town of Kirkland and is the more active. Thinly stratified and jointed beds aid in the quarrying of this rock which appears to have satisfied the local need for road metal. An abandoned quarry in the Spencer settlement, now filled with water, is located in Pulaski sandstone. The beds of sandstone range from two inches to one foot in thickness.

SAND AND GRAVEL

Some of the sand and gravel used for road metal or in construction work originates from isolated kames in the Oriskany and Sauquoit valleys, but most of it comes from the Lake Iroquois sands in the vicinity of Rome. The best deposit in the Rome district is known as the Byams gravel bed and is used in the construction of the city and state highways. At the time of this survey these excavations measured 900 by 900 by 20 feet. The material washed yields gravel in sizes up to two inches. Three hundred tons a day was considered a good day's production.

The Sullivan Sand and Gravel deposits are located one and one-half miles northwest of Rome and two miles west of Ridge Mills. The excavation, measuring 500 by 500 by 50 feet, consists of stratified gravel and cross-bedded sands (figure 33). This product is used by both the city of Rome and the State in the construction of highways, and is washed. The deposit consists of 50 per cent sand and 50 per cent gravel.

As needs develop on this quadrangle, it is quite probable that there will be found sufficient sand and gravel deposits in the Floyd, Whitesboro and Rome areas to meet unusual demands. The delta, kame and esker deposits in the Whitesboro area alone, with their accessibility to the Utica market, should prove an ample source for constructional purposes.

It has been reported to the writer that some of the delta sand on the Doyles' place between Coleman and Oriskany was used as a molding sand because it possessed certain bonding qualities.

As Utica obtains most of its building and concrete sands from the terraced delta beds and kame deposits at Boonville and Forestport, it would appear that the sands and gravel in this area are at present of more potential economic value than of immediate value.

BRICK CLAYS

Some clay, taken from the flood plain of the Mohawk on the north side in the meander loop just north of Utica near the eastern edge of the area, has been used in the manufacture of brick. These clays originated as deposits of finely comminuted material in bodies of standing water along the course of the Mohawk when it was receiving water from the Great Lakes. Any section of the Mohawk today would show alternation of beds of gravel, sand and clay, the separate beds reflecting the different conditions of flowing and quiet waters. The quiet waters, of course, are reflected in the deposits of clay (Nevin, 1929).

Mohawk Valley Brick and Supply Company

At the time of this survey, the company was operating in a pit measuring 125 by 50 by 7 feet, which gave a section topped by three to five feet of marshy soil. Considerable vegetable matter is admixed with the clay as a result of recent flooding of the Mohawk.

Brick making in this area is a semimechanical process, which combines both primitive and modern methods, the former in which no power is used and the latter in which a limited amount of power is used. The semimechanical method of making bricks where a limited amount of power is used is employed by the Mohawk Valley Brick and Supply Co. at Yorkville, N. Y. The process, in brief, comprises excavating, mixing, molding, coloring, drying and burning. In detail the process consists of introducing the proper amount of sand before and after the mixing stage. The prepared clay is then forced into six-tined wooden molds which are fastened on a conveyor belt, previously sent through fine sand containing powdered hematite. The hematite serves the purpose of allowing the bricks to slip out of the molds easily as well as furnishing the bricks with a much needed coloring, which is not supplied in sufficient amounts by the ferrous iron in the clay element. The conveyor carries the molded bricks to the drying yard where they are stored in racks under a roof for a period of a week. These are known as green bricks. Some of the water in the pores passes off at this stage but most of it is driven off during the burning stage, as well as carbon dioxide and sulphur dioxide. This results in a more porous dry brick. Further heating causes the clay to shrink and still further heating causes it to fuse, all of which·tends to increase the density, the maximum density being reached when the clay begins to vitrify.

The color in the Mohawk brick is due not only to the color of the hematite but also to the oxidation of any ferrous iron contained in the clay. The kiln is of circular type consisting of a series of chambers, in a rectangular two-story brick building. The lower story has an oval shaped drying tunnel about nine feet high encircling the interior. There are six openings from this tunnel. As it is a down-draft kiln, the fire is kept burning at an even heat in the second floor. In 1934 the fire was kept burning from the 4th of July until the following March when the kiln was shut down for repairs. Some two to three million bricks are produced each year from this local clay.

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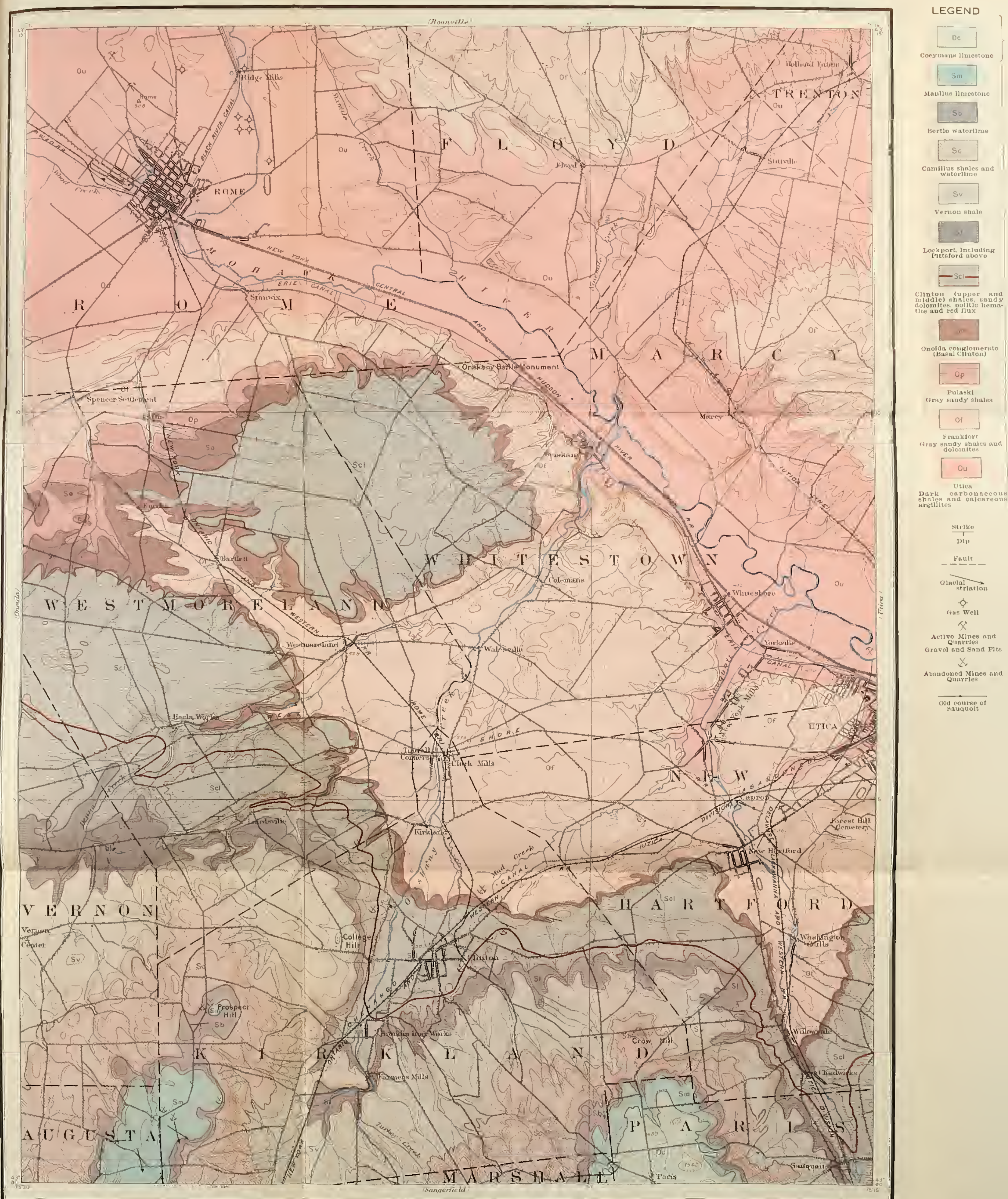

Topography by U. S. Geological Survey and the State of New York, 1893
Topography resurveyed 1941-1947, and map republished 1947 as Rome Quadrangle

GEOLOGIC MAP OF ORISKANY (ROME) QUADRANGLE

Scale $\frac{1}{62500}$

Miles

Kilometers

Contour interval 20 feet

Datum is mean sea level

Geology by Nelson C. Dale, 1933.

Geology of the Saranac Quadrangle, New York

By

A. F. BUDDINGTON

Temporary Geologist, New York State Museum

NEW YORK STATE MUSEUM

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ILLUSTRATIONS

Figure 1—City of Saranac Lake from Mount Baker. Mount Pisgah in foreground to right, Moody pond in left foreground, Lower Saranac lake in background.

GEOLOGY OF THE SARANAC QUADRANGLE, NEW YORK[1]

By

A. F. Buddington
Temporary Geologist, New York State Museum

INTRODUCTION

GEOGRAPHIC LOCATION

The Saranac quadrangle (figure 2) lies in northern New York and within the northern part of the Adirondack mountains, between 44° 15′ and 44° 30′ north latitude and 74° and 74° 15′ west longitude. The east half of the quadrangle is in Essex county and the west half in Franklin county. Parts of the townships of North Elba, St Armand, Franklin, Brighton and Harrietstown lie within the area.

PREVIOUS GEOLOGIC WORK

The first published record of geologic work within the area of the Saranac quadrangle, in so far as the writer has been able to ascertain, was that by Ebenezer Emmons (1842) as a product of his survey (1836-42) of the Second Geological district of New York. No details are given by him for this quadrangle, but his general description would imply that the area was underlain in part by hypersthene (anorthositic rock) rock, and in part by gneiss (syenite-quartz syenitic rocks) with subordinate granite and associated hornblende (metagabbro and amphibolite). The rocks in parentheses are the corresponding names now in use. He also gave a quite clear picture of the general topography.

Half a century passed before further systematic geological work was undertaken in the Adirondacks, when under the auspices of the New York State Museum studies of the areal geology by townships and counties were begun in 1892 by J. F. Kemp in the eastern and southeastern Adirondacks, in the same year by C. H. Smyth jr in the northwestern and western Adirondacks, and in 1893 by H. P. Cushing in the northern Adirondacks. During the following score of years these three men, together with

[1] Manuscript submitted by author for publication December 1944.

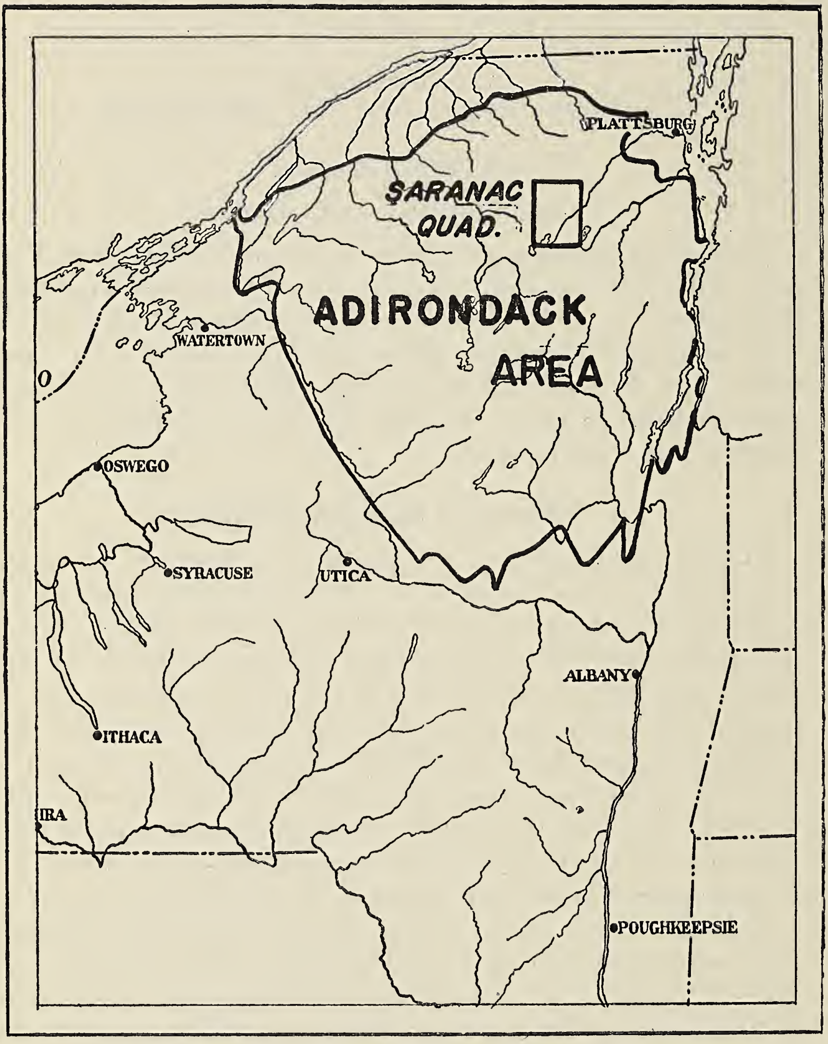


FIGURE 2—Index map showing location of Saranac quadrangle

D. H. Newland, who was associated with Kemp on some of the areal work but more especially in studies of the mineral deposits, laid the foundations for our knowledge of the geology of the Adirondacks and the bases for further progress.

The first detailed references to the geology of the Saranac area are in a report by Cushing (1900). Cushing gave a map showing in broad outline on a small scale the distribution of the anorthositic rocks, gneisses, syenite, and Grenville respectively for the western half of the quadrangle. In a report on the Geology of the Northern Adirondack Region he (Cushing, 1905) gave a general description and interpretation of the geology of an area which embraced the Saranac quadrangle. A most excellent semipopular account and exposition of the geology of the southwestern two-thirds of the quadrangle and of a part of the adjoining St Regis quadrangle is given by Alling (1919). This report contains both a geologic map and a map of the glacial geology for the region involved. The history of the glacial lakes which formerly occupied the area is in particular set forth in great detail here. Indeed, much of the present report on the glacial lake deposits is based largely on Alling's work, though the writer has himself systematically covered the whole quadrangle for purposes of geologic mapping and for structural data not given by Alling. The general setting of the structures of the rocks of the Saranac area with relation to the structural phenomena of the great anorthositic massif as a whole has been set forth in detail by Balk (1931) in his monographic study entitled "Structural Geology of the Adirondack Anorthosite." A memoir by Buddington (1939) on "Adirondack Igneous Rocks and their Metamorphism" sets forth in considerable detail the problems and certain interpretations of these rocks, presents a review of the literature, and a geologic map of the northwestern Adirondacks.

The following geologic reports have been published by the New York State Museum for quadrangles which touch or border the Saranac area: Lyon mountain (Miller, 1926), Lake Placid (Miller, 1919), Mount Marcy (Kemp, 1921), Long lake (Cushing, 1907) and Santa Clara (Buddington, 1937).

TOPOGRAPHY

The region of the Saranac quadrangle, except for the southeast corner, is part of a hilly intramontane basin ranging in general between 1500 and 2000 feet in altitude. It will be described in more detail in a chapter on physiography. The southeast corner of the area lies in a high mountain belt, 3200 to 3921 feet in altitude, which forms a part of the southeastern border or mountain rimrock of the basin. Within the basin there are two ridges higher than normal, the Boot Bay-Shingle Bay Mountain block, and the Katy Mountain ridge.

If the highest upland surfaces of the hills throughout the Adirondacks are imagined to be extended in space to form one continuous surface, we have the form of an asymmetric dome with the highest portion in the northeast, a relatively gentle descent to the northwest and southwest, a little steeper slope to the southeast, and at the northeast a steep slope to the north and northeast. The group of mountains with the highest altitudes lies just to the east (Lake Placid quadrangle), south (Santanoni quadrangle) and to the southeast (Mount Marcy quadrangle). It includes Mount Marcy (5344 feet), Mount McIntyre (5112 feet), Mount Whiteface (4872 feet), Mount Dix (4842 feet), Gothic mountain (4738 feet), Mount Colden (4713 feet), Giant mountain (4622 feet) and Santanoni Peak (4621 feet). There are two narrow belts of high mountains running northeast-southwest across the central Adirondacks. One of these extends southwest from the Dannemora quadrangle through Mount Whiteface and Moose mountain, southwest to the Piseco Lake quadrangle. The other extends from Lyon mountain southwest through St Regis mountain on to the Number Four quadrangle. The Saranac area lies in a trough or basin between these two mountain ranges. Its southeast corner actually includes a part of the high mountains of the highest range. An east-west cross range lies just to the south of the quadrangle and includes such peaks as Mount Marcy, Street mountain, the Sawtooth mountains, Ampersand mountain and Mount Morris on the west.

The location of the present drainage divides of the Adirondacks correspond roughly, though with many subordinate deviations to the slopes of the aforementioned dome. As a consequence part of the headwaters of the major rivers (Raquette, St Regis, Saranac and Ausable or their tributaries) of the northern Adirondacks head in the Saranac quadrangle. It thus lies on the flank of the highest part of the dome and from it the whole drainage of the northern Adirondacks radiates outward to the northwest, north and northeast. The headwaters of the Raquette and St Regis rivers cross the St Regis range of mountains.

The highest point in the quadrangle is Moose mountain (locally called St Armand) with an altitude of 3921 feet though McKenzie mountain (locally called Saddleback, 3872 feet) is not much lower. The lowest point is where the Saranac river crosses the east border of the quadrangle at an altitude of about 1450 feet. The maximum relief is thus about 2471 feet. The lake levels, and swamps and flats of the major valleys are in general between 1534 feet (Lower Saranac lake) and 1668 feet (Rainbow lake) altitude.

The area lies within the great "lake belt" of the central Adirondacks and there are many lakes, ponds and swamps. Sandplains are also common.

CULTURE

The mountains, hills and swamps which form most of the quadrangle are forested. Lumbering was formerly a flourishing industry but is now quiescent. Dairying is carried on throughout the gently rolling, relatively lowland belt in which the settlements of Vermontville, Bloomingdale, Gabriels and Harrietstown are located, and in local clearings elsewhere along the main roads.

The area is, however, one pre-eminently given over to recreation purposes, for which it is admirably suited.

SUMMARY OF BEDROCK GEOLOGY

The bedrock geology of the quadrangle can not be satisfactorily mapped and studied in much of the area because of the paucity and poorness of outcrops, especially in critical zones. The valleys and lower slopes of the hills and mountains are so cloaked with a veneer of drift and glaciofluviatile and glacial lake deposits that outcrops of rock can be found only at or near the tops of the hills and in a few roadcuts. On the forested hills, as most are, the outcrops are so obscured by lichens, moss and forest litter, that they present most discouraging objects for study. Several areas have therefore been left unmapped and considerable generalization is involved in some of that portion which has been mapped.

A tabular statement of the rocks exposed in the area is given in table 1, arranged in order of age with the oldest at the base.

Practically all the Precambrian rocks in the quadrangle except the diabase dikes and some of the more massive Marcy anorthosite have a foliation and are true gneisses though the term gneiss will not always be used when referring to the different types. The strike and dip of the planes of foliation of the rocks are plotted on the geologic map and their arrangement in part indicates simple synclinal and anticlinal structures but in part more complex relationships. A series of figures (figures 14A, B, C, D) has been prepared which attempts to show the history of the development of the bedrock geology by means of a series of vertical sections through the upper part of the earth's crust representing successive stages. Stage IV, figure 14D is a cross section showing a generalized picture of the subsurface relationships and structure of the rocks as we infer them to be now. The diabase dikes are not shown.

GEOLOGIC SETTING OF CITY OF SARANAC LAKE

The city of Saranac Lake has a unique geologic setting, for the rocks in the area within four miles and to only a little lesser extent within a mile of the post office show in their varied characters and structures an epitome of the geology of the Adirondacks as a whole. As such its description will serve as an advance summary of the salient features of the geology of the quadrangle.

Grenville metasediments. The oldest rocks in the vicinity, as in the Adirondacks as a whole, are the Grenville metasediments which are well-exposed on Mount Pisgah to the north of the city. They comprise beds of glassy-looking though coarsely crystalline white quartzite, in part thin-layered with pyroxenic granulite, with associated rusty brown-weathering pyroxene-feldspar gneiss and layers of dark to black amphibolite with a pepper and salt appearance (white plagioclase and black hornblende and pyroxene). The rusty surface-color of some beds is due to the weathering of a small amount of disseminated pyrite in the rock. These beds are inferred to represent strongly metamorphosed and in part somewhat modified equivalents of sandstone, calcareous sandstones and calcareous shales or impure limestones. The primary sedimentary rocks have been recrystallized and reconstituted with in part some additions of materials by magmatic solutions and may be called metasediments.

Anorthositic complex. The next youngest rock is the anorthosite with its quite subordinate related gabbroic variants. This constitutes the entire southern third of the quadrangle and forms part of the north border of the great Adirondack anorthosite massif which occupies some 1200 square miles to the west, south and southeast. The basins in which lie Lower Saranac, Kiwassa and Oseetah lakes are eroded in anorthosite. The road from Ray Brook through Saranac Lake to Tupper Lake might truly be

TABLE 1

Geologic Column

Pleistocene		Till, stratified sand and gravel
	UNCONFORMITY	
Lower Paleozoic		Potsdam sandstone, present only as boulders and pebbles in this quadrangle
	UNCONFORMITY	
Precambrian	Intrusive Igneous Rocks Metamorphosed to Gneisses with Exception of Diabase	Diabase, as dikes
		Hornblende granite gneiss, red to gray, as lenses and phacolithic sheets
		Saranac differentiated quartz-syenitic sheet; mafic pyroxene syenite, syenite and pyroxene quartz-syenite, all even-grained, and gneissic Loon Lake differentiated quartz syenitic sheet; pyroxene syenite, quartz-syenite and pyroxene granite, all with coarse phacoidal gneissic structure
		Metagabbro, gabbro gneiss and amphibolite, as sheets and lenses
		Marcy and Whiteface anorthosite and gabbroic anorthosite. Local gabbro and norite and mafic gabbroic and mafic noritic rocks.
	Grenville Metasediments	Impure crystalline limestones, paramphibolite, quartzite, pyroxene quartzite and granulite, pyroxene-feldspar and quartz-feldspar gneisses and skarn

called the "road of anorthosite" for every road cut and rock exposure without exception is through this rock. Magnificent exposures of massive anorthosite may be seen on Mount Ampersand and along the state highway to the west of where the trail to Mount Ampersand leaves the main highway. The flashing cleavage faces of the andesine feldspar crystals of which the rock is composed to the extent of 90 per cent or more may be seen in the rock of *fresh* road cuts as one rides by. Amongst nearly a thousand varieties of igneous rocks which are known from the world as a whole, anorthosite in masses of the Adirondack type is unique in that it is the only one which is wholly restricted to a particular geologic age, in this case, the Precambrian. Not only are such uniform masses of anorthosite restricted to the Precambrian but they are also characteristically present in large areas of older Precambrian rocks in most continents. A score of such anorthosite bodies are found in the older Precambrian areas of eastern North America from Virginia to Labrador. The anorthosite massifs of the Adirondack type[1] form, therefore, in a very special and restricted sense, bodies of "very ancient" rock of the earth's crust. The Adirondack anorthosite must be well over a billion years old. The anorthosite is interpreted as the product of consolidation, with some differentiation, of a magma with the primary composition of gabbroic anorthosite which was intruded into the Grenville series. The Grenville metamorphic rocks are thus still older than the anorthositic complex.

Locally, as a quite minor facies, there is associated with the anorthositic rocks a heavy rock, practically black though with a few white feldspars on fresh surface, and weathering dark gray to rusty brown. This facies may either be parallel to the foliation of the anorthosite or it may cut it and include blocks. It is exposed on the hill seven-eighths of a mile southeast of the post office, on the top of Baker mountain east of its peak, in road cuts on the highway three and one-half miles west of Saranac lake and in the hills north of McCauley pond. Such rock is composed predominantly of pyroxene associated with a considerable to substantial percentage of ilmenite and magnetite.

Skarn. A small crescent of skarn just south of Saranac lake forms a thin screen or parting between the anorthosite and the mafic syenite to the north. The skarn is exposed in the vicinity of the reser-

[1] Anorthosite does occur, however, in certain localities outside the Adirondacks as a differentiated stratiform layerlike facies of thick gabbroic or noritic sheets which are of younger age than the Precambrian, but such layers have a different mode of occurrence from the more or less uniform masses of the Adirondack type and are usually composed of a more calcic plagioclase.

voir on top of the hill one-half mile south of the city post office. It consists of a medium-grained aggregate of reddish brown garnet and dark green pyroxene. There are also veinings and dikes of pink syenite in it. Where the skarn outcrops in a small ledge on Lake street it is a dark green pyroxene granulite. The anorthositic rocks carry a slightly higher percentage of ferromagnesian minerals adjacent to the skarn and locally have included small fragments and shreds of dark skarn. The skarn is interpreted as limestone into which silica and dark silicates have been introduced to such an extent that the limestone has been wholly reconstituted and replaced by garnet, pyroxene and other skarn minerals. The silica and silicate materials were carried by solutions originating in the anorthositic magma at the time of its intrusion. Another hill showing good exposures of skarn is that one and three-eighths miles south of Saranac lake. Here the skarn is in part associated with anorthosite and in part with intrusive syenite, and much of the skarn consists of pyroxene and microcline.

Metagabbro, gabbro gneiss and amphibolite. The next youngest rock after the anorthositic series is diabase or gabbro and its metamorphic equivalents, dark heavy rocks, composed, where unaltered, of labradorite and pyroxene with subordinate olivine and accessory ilmenite and magnetite. Usually this rock has been deformed and reconstituted to metamorphic facies which vary considerably in nature and appearance but which may be called metagabbro, gabbro gneiss, and amphibolite, depending on their degree of metamorphism. These rocks are most extensively developed in the hills west of Vermontville but a narrow band of amphibolite caught up in the younger granite is exposed on the hill slope east of Harrietstown about four miles north northeast of Saranac lake. The gabbro and its metamorphic facies quantitatively forms a subordinate element amongst the igneous rocks of the Adirondacks though it is present in every quadrangle. It was intruded for the most part as sheets and lenses conformable with the bedding of the Grenville series. It is similar to gabbroic rocks found in many mountain ranges throughout the world.

Saranac quartz syenitic sheet. Most of the city area of Saranac Lake has an arc-shaped form lying in a lowland area extending southeast from Colby pond swinging east across the Saranac river and then northeast along the river where are Moody pond and Trudeau. Geologically this arc is underlain by the Saranac sheet of syenitic rocks which lies between the anorthosite of the hills on the south and east and the Grenville rocks of Mount Pisgah. The great bulk of the rocks is a mafic syenite gneiss which is dark green on fresh surface. It is exposed in all the rock cuts within the city itself, in the quarry at the northeast end of Moody pond, and at the top of Baker mountain. Most of the retaining walls in the city are built of blocks of this rock. The syenite is darkest in color and carries the highest percentage of dark minerals in the outer part of the arc near the anorthosite and skarn. It is garnetiferous. Just below the Grenville schists of Mount Pisgah it grades into a quartz syenite which has much less dark mineral, 15-20 per cent quartz, and is light green in color. This quartzose facies of the syenitic rocks is exposed in a road cut just south of Trudeau and along the highway for a mile northwest of Peck's Corners. The syenitic rocks are the product of a magma which was intruded as a sheet between the overlying Grenville beds and the underlying anorthositic rocks. As indicated the sheet has a stratiform arrangement and it grades upwards from a dark heavy mafic rock with many included shreds of skarn in the outer arc at the base of the sheet into the lighter weight and lighter colored more siliceous facies at the inner edge of the arc and top part of the sheet. The syenitic magma was younger than the Grenville series and the anorthosite, and yielded a somewhat varied suite of rocks as a result of local incorporation of skarn and of differentiation. The pyroxene syenites and quartz syenites, like the anorthosites, are predominantly and peculiarly found only amongst the most ancient, the Precambrian, rocks of the earth's crust.

Granite. The next youngest intrusion is a granite, reddish to pale greenish gray in color. Near the city it is exposed as dikes within the anorthosite in the eastern half of the Baker Mountain ridge but it is present in volume in the hills south of Harrietstown. On the hilltop west of the Harrietstown church and schoolhouse the contact between the green quartz syenite which forms the west half of the hill and the red granite which forms the east half is exposed. The range of hills northeast of Mount Pisgah and two to five miles from Saranac lake are composed of granite with shreds of amphibolite derived from the Grenville series. The granite is a representative of the youngest major igneous intrusions in the Adirondacks. All the older rocks were strongly deformed and the Grenville series was folded at a period before the intrusion of the granite magma, for elsewhere in the Adirondacks the granite has been found to transect the older folded structures. The granite is a normal type similar to granites found in many mountain ranges. The age of the granite is probably around a billion years. By methods based on the rate of disintegration of uranium in the mineral uraninite to yield radium, granite pegmatite near Richville, New York has been determined to be 1,094,000,000 years old, (Shaub, 1940, p. 485) and similarly Marble (1943, p. 32-40) has determined by a study of allanite crystals in a granite pegmatite from Mount Whiteface that they are about 1,200,000,000 years old. These granite pegmatites are thought to be related to granites of the same age as that exposed in this quadrangle.

Metamorphism and plastic flowage. A study of the anorthositic rocks will show that locally there are all gradations between a coarse almost massive rock with feldspars an inch or two in length through an augen gneiss in which half the feldspars have been completely crushed, recrystallized and flattened into lenticular aggregates to a rock which has but a few relic fragments of the original feldspars but is almost wholly a much finer-grained granular rock. Bands of such granular rock may be intercalated with coarser less deformed facies. In much of the granulated rock red garnet has formed as a result primarily of chemical reaction between the dark minerals and certain constituents of the plagioclase. The gabbroic rocks in particular well show the results of deformation and metamorphism. Rocks originally consisting of labradorite, olivine, augite and hypersthene with a coarse diabasic texture have at extreme been reconstituted to granular aggregates of andesine, garnet, and recrystallized augite and hypersthene. The syenitic rocks also consist of a granular aggregate of polygonal grains with plane faces, a mosaic texture. In a syenitic rock of this nature the normal primary texture would be one wherein the grains intricately interlocked with each other, a denticulate texture resulting from interference of the grains during growth from a magma. The mosaic texture is typical of rocks which have been deformed after consolidation. In the syenitic rocks, especially the mafic facies, garnet has also developed through chemical reaction between the dark minerals and certain constituents of the plagioclase. The reduction in size of grain, the recrystallization and reconstitution of certain portions of the anorthositic rocks and of the gabbroic and syenitic rocks and the development of a strong secondary foliation are all interpreted as the product of rock deformation and metamorphism under appropriate conditions of great depth (at least several miles depth), high temperatures (perhaps 600° C or thereabouts) and in the presence of a slight amount of vapors or solutions. It is thought that under the conditions prevailing, the mountain-making forces were of such magnitude as to literally make the strongest rocks flow even while they were either solid or essentially so. The thickening of the Grenville rocks at the ends of the syncline and their thinning on the limbs is likewise attributed to some actual plastic flowage of rock from the limbs towards the ends of the syncline.

The granite, like the older rocks, is a gneiss and shows evidence of strong deformation and flowage of the solid minerals but it also has pegmatite veins crossing the foliation which are massive. These pegmatite veins are thought to represent residual magma pressed out from the interstices of a solid mineral aggregate constituting the almost wholly crystallized magma, or in other words, the granite. This implies that the granite was deformed before quite complete consolidation and that deformation ceased before the crystallization of the massive granite pegmatite veins.

Basaltic diabase. Finally at a much later date than the granite pegmatite veins, probably as much as a half billion years later, there was a period of intrusion of basaltic diabase dikes. Only a few of these are present in this quadrangle, for they are more common in the eastern and northern Adirondacks. One is very well-exposed in the road cut four miles southeast of Saranac Lake or three-fourths of a mile east of Ray Brook on the Lake Placid highway where it is conspicuous as a black band in the white anorthosite. These dikes are of late Precambrian age. None are over a few feet wide in this quadrangle and they can not be traced more than a few hundred feet. Many of the dikes show a pronounced stony or denser texture against the wall rock than in their core. This must be due to quick chilling of the magma against the walls and indicates that the diabase came into cool country rocks relatively near the surface (within several miles or so) and therefore under totally different conditions from all the other intrusives. The diabase dikes are the youngest igneous rocks in the area and have suffered no deformation. Part of the erosion which led to the ultimate exposure at the earth's surface of the originally deep-seated older rocks must thus have occurred between the period of the granite and of the diabase intrusions.

Synclinal structure. The city of Saranac Lake also has a location of peculiarly great geologic interest in respect to the relationship of its site to the structural framework of the rocks. It lies at the south end of a major structural element, the Bloomingdale syncline. The south part of the Bloomingdale syncline occupies part of a great structural sag or depression in the roof of the anorthosite massif which lies at some depth beneath. The Saranac syenite sheet, the skarn and Grenville series, and a granite sheet are all involved in the syncline or canoe-shaped structure whose keel at the south pitches down at first to the north-northwest but then swings to the northeast farther north toward Bloomingdale. The Grenville, syenite, and granite form elongate basinlike shells successively overlying each other, the first two yielding hollow elliptical-shaped belts as surface exposures, and the latter an elliptical area. Similar synclines and their complementary structures, the anticlines, are characteristic of the strongly deformed rocks of the Adirondacks.

Potsdam sandstone and pre-Potsdam sandstone erosion interval. Thirty miles to the northwest, north and northeast, the Precambrian rocks are overlain by a relatively flat-lying layer of Potsdam sandstone. In the northwest the surface of the Precambrian on which the sandstone rests is one of very little relief and is therefore designated a peneplain. It is probable that the whole northern Adirondacks was once such a peneplain and that this was overlain by the Potsdam sandstone and perhaps younger sedimentary beds. A very long period of erosion is required to yield such a relatively level surface as a peneplain on rocks of such varied resistance to erosion as those of the Precambrian. This period of erosion must, of course, have preceded the deposition of the Potsdam sandstone in Early Paleozoic time. Subsequent to the deposition of the early Paleozoic sediments the area now constituting the Adirondack mountains was domed up, in part, with accompanying faulting. Whether this happened more than once is a problem. In any case the Paleozoic sediments were stripped off of the surface of the high lying Saranac area which formed part of the core of the dome and the underlying rocks were by erosion etched into the present mountainous topography. It may be pointed out that whereas the Precambrian rock *structures* and the Precambrian *rocks* of the Adirondack mountains are among the *most ancient* of the earth's crust and literally part of the foundations of the North American continent, the *topographic relief,* that is the *mountains themselves,* may be relatively *young,* no older than those of the Appalachians and may be even as young as Tertiary in age, and not over 50 millions of years old.

No Potsdam sandstone is now present in the area of the Saranac quadrangle but pebbles, cobbles or slabs are found at all levels from the bottom of the valleys to the tops of the mountains, carried here from the present areas of exposure by the Pleistocene ice cap.

Pleistocene deposits. Drift, the sedimentary deposits made by the glacier ice cap which covered the Adirondacks during the Pleistocene, covers the lower flanks of most of the hills. The drift varies from a general mixed aggregate of boulders, sand, and clay constituting till to stratified sands formed by melt waters of the waning glacier in the valleys and in temporary lakes formed by ice obstruction to the normal drainage. The most interesting aspects of the drift are two well-developed eskers, here named the Adirondack esker and the Saranac esker. They are composed of intermittent elongate hills of stratified sand and gravel. The Saranac esker is well-exposed in the large gravel pit three miles northeast of Saranac lake and in the gravel pits just to the east of the railroad for a mile south of the river crossing. The road through the Trudeau sanitarium lies on the crest of an esker ridge as does the Will Rogers sanitarium. These eskers are further discussed in the chapter on physiography. Turtle pond, the little ponds east of Ray Brook, Owl pond and Pine pond are interesting as examples of basins that are the product of blocks of ice which during the waning of the ice cap were left buried in the sand deposits, and on subsequent melting yielded a closed depression in the sands. Such lake-basins are the slightly modified molds of former ice blocks.

The anorthosite has a tendency to break out in enormous blocks on weathering as at the east headland of Shingle bay on Lower Saranac lake. Tremendous blocks were similarly broken off and transported by the ice of the Pleistocene. The hill on which the Ray Brook sanitarium is located west of Ray Brook and north of Ames Mills is littered with an abundance of such ice-transported huge anorthosite boulders.

PHYSIOGRAPHY

INTRODUCTION

There is a great variety in the nature and character of the relief, topography, and other natural features of the Saranac area. The origin of the physiographic forms and phenomena deserve more detailed study than has been given them in the course of the present survey which was devoted particularly to the bedrock. A discussion based on the data available, however, will be given.

The major features of the topographic relief of the Saranac quadrangle are consequent upon the interplay of several major factors such as the nature and inherent resistance to weathering and erosion of the underlying bedrock, the foliation and linear structure of the rocks, the presence of fault lines and joints.

SARANAC INTRAMONTANE BASIN

The broad features of the nature and origin of the major topographic features of the Saranac quadrangle can only be described and understood in the light of the larger features of which they are a part and which involve neighboring areas.

For example careful study of the data given in figure 3 shows that

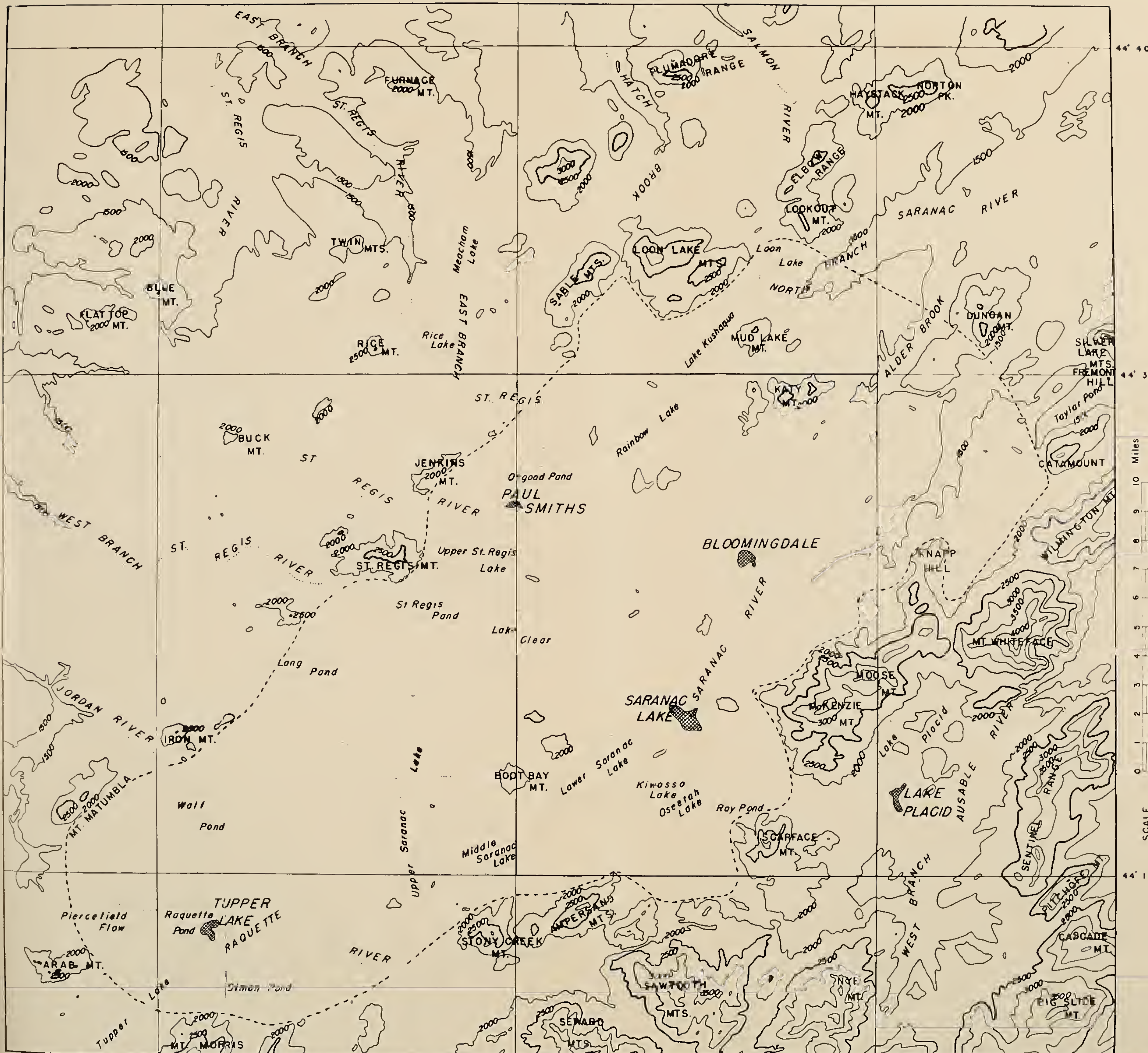


FIGURE 3—Map showing position and relationships of "Saranac Intramontane Basin" to the surrounding mountains. Area of the Basin is within the broken line. Contours are in feet above sea level and are taken from U. S. Geological Survey topographic maps.

all the Saranac quadrangle except the southeast corner is part of a large oval-shaped basin, inclosure or park of relatively low relief within a much broken rim of high mountains. The longer diameter of this area is a little over 35 miles, the width varies from ten to 15 miles and the axis strikes northeast. The mountain rim is outlined by the following mountains: Morris, Stony Creek, Ampersand, Scarface, McKenzie, Moose, St Armand, Whiteface and Wilmington on the southeast, Catamount, Silver Lake, Duncan, Lookout and intervening hills on the northeast; Lookout, Elbow, Loon Lake, Sable, Jenkins, St Regis and Iron mountains on the northwest and mounts Matumbla, Arab and Morris on the southwest. The continuity of the rim is at intervals breached by valleys but these mountains, all of whose peaks are above 2500 feet, do outline a skeleton wall within the inclosure of which there is an area of over 450 square miles with but three small peaks reaching 2500 feet. There are within the area thus inclosed but few hills reaching an altitude of as much as 2000 feet and nearly all of the basin lies between altitudes of 1540 and 2000 feet, with, in general, a relief of not over 460 feet at the maximum and commonly not over 300 feet. By contrast the relief in the mountain belt along the southeast border is commonly 1500 to 2500 feet and in the mountain rim along the northwest border 1000 feet or more. The relatively moderate relief of the basin area is reflected to a very marked degree in the geography and culture. It contains more miles of improved road than any other equal area in the Adirondack mountains proper though it lies within their heart. The largest town of the Adirondacks, Saranac Lake, is also located within its confines as well as Tupper Lake, Paul Smiths, Bloomingdale, Gabriels and Vermontville. There are about 50 lakes of a mile or more in diameter including such large and well-known groups as the Saranac and St Regis lakes and in addition there are well over a hundred ponds on the basin floor, all with altitudes between 1527 feet (Lake Flower) and 1668 feet (Rainbow lake). Figure 4 shows the nature of the basin and of the mountain rim on the Saranac quadrangle. An excellent view of the basin and of its nature with respect to its mountainous rim may be had from the forest observation tower on St Regis mountain, to which there is an excellent trail starting from the power plant about two and one-half miles west of Paul Smiths.

Several possible origins for this unique feature of the Adirondacks may be considered, such as a variation in the nature and resistance to weathering of the underlying bedrock, the structure of the bedrock, the location of major drainage lines, deposition of glacial drift in river valleys, normal erosion and faulting.

The bedrock underlying the basin comprises the same types as those which form the mountains. Half the area is carved in anorthosite of the same character as that which forms the very highest group of mountains in the Adirondacks. The other half of the basin is underlain by granite, syenite and metagabbro, rocks which are likewise resistant and are the same as those which form the peaks of part of the inclosing mountains. The Grenville metasediments, which are in general members of the Precambrian rocks least resistant to erosion, occupy only a few square miles and can not be the controlling cause for the relatively low altitude of the basin as compared with the mountains. The rocks of the lake belt are in no sense weaker than those in the belts of higher altitude and greater relief adjoining. This is the conclusion of Cushing and the writer agrees with it.

The longer axis of the basin strikes northeast which is the general direction of the strike of the foliation of the rocks in the northern Adirondacks. In detail, however, the borders of the basin are so inconsistent with the local foliation and with the contacts of different kinds of rock of different degrees of resistance to erosion that this type of structure can not be appealed to as a major controlling factor in the orientation and location of the basin. For example the basin is oriented at about right angles to the longer axis of the Great St Regis-Marcy anorthosite mass, and it extends right across it without any noticeable change. No difference in the degree of intensity of jointing has been noted between the rocks of the mountains and those of the basin.

The hypothesis may be raised that the basin is a normal deep major river valley or combination of normal deep river valleys in which glacial drift has been deposited to so great a depth as to yield the broad surface of very gentle relief above which project numerous rock ridges to form relatively low hills. This seems highly improbable as rock ledges show locally in the course of all major streams across the basin or short distances below, as at the outlet (altitude 1575 feet) of Upper Saranac lake at the Bartlett club house; at the locks at the outlets of Middle Saranac (altitude 1536 feet) and Lower Saranac lakes (altitude 1534 feet), at the village of Saranac Lake, and at Franklin falls (altitude 1440 feet) along the Saranac river; at Piercefield (1540 feet) and Raquette falls (altitude 1620 feet) on the Raquette river; at the outlet of Lake Meacham (altitude 1551 feet) on the East Branch of the St Regis river; and at 1475 feet on the St Regis river. Some of these ledges are very probably not at the lowest level of the preglacial valleys but it seems equally probable that some of the lower ones are at or near the preglacial level of the river valleys

FIGURE 4—View across Saranac intramontane Basin from St Regis mountain. Lake Clear at right, Lower and Upper St Regis lakes at left. Spectacle pond in left foreground. Mount Whiteface in central background with Mount St Armand and Mount McKenzie to right.

and that 1450 feet is certainly the lowest level that any preglacial valley could have been within the basin. This precludes the possibility of very thick glacial drift in a deep valley being a satisfactory explanation for the origin of the basin though it has been a factor in materially reducing its general relief.

Another hypothesis to be considered is that the basin is the normal product of erosion by one or more major rivers. The headwaters of both the main river and of the North Branch of the Saranac lie within the basin. The Raquette river crosses the southwest end and a narrow belt of the northwest border zone is in considerable part drained by the headwaters of the St Regis river and its tributaries but at the present time most of the basin is part of the water shed of the Saranac river. Lake Clear is only six miles from the Saranac river at Saranac lake but the water draining from it actually flows from 25—30 miles in a circuitous route through a string of lakes to reach the river and seems clearly to have here a post-glacial channel. Lake Clear, Long pond and Upper Saranac lakes which are at the head of the Saranac drainage may in preglacial time have drained to the Raquette river for only a very low divide with glacial filling now separates them at the south end of Upper Saranac lake where the lake is less than three miles from the river at Axton. In the 13½ miles taken in a straight line along the basin from the outlet of Middle Saranac lake to the narrow valley below the 1500 foot contour the river drops only 36 feet or less than three feet a mile on the average whereas in the next 14 miles it drops 184 feet or 13 feet a mile. Similarly the St Regis river has a low rate of drop for its six miles along the basin (nine feet a mile) and a high rate of drop for the next 14 miles below the basin (18 feet a mile), and the Raquette river drops only five and one-half feet a mile in the 16 miles from Long lake to Piercefield on the edge of the basin and 15 feet a mile for the average of the next 14 miles below it. As has been noted, rock is exposed at a few localities in the bed of the courses of all these rivers across the basin and in particular near the edges of the basin and near the upper reaches of the rivers. There is thus some evidence that the present valley levels, though locally different in altitude from those of preglacial time, can not in general be very markedly different. The rocks at the edge of the basin where the rivers start their more rapid drop in altitude are the same types as those of the basin so that the basin can not be interpreted as a local base level developed as a consequence of the resistance of harder rocks at appropriate altitudes which temporarily checked the downcutting of the rivers. The basin is not along the lower or middle reaches of the rivers where broad valleys might be expected but is at the headwaters of the main streams or tributaries of the St Regis, Saranac and Raquette. The basin then is not satisfactorily explained as a product of normal river erosion.

Cushing (1900, p. 25-28, 83-89) first pointed out the existence of a great "Lake Belt" in the heart of the Adirondacks and stated his belief that the district is too sharply and abruptly marked off from adjoining districts to be explained by preglacial drainage and that it is a structural depression, a dropped fault block; the district to the east having been largely uplifted with respect to it, that to the west much less so. Cushing included in the "Lake Belt" an area extending from Loon lake some 75 miles south southwest to First lake of the Fulton chain. The Saranac Intramontane Basin as here defined forms the northeast part of Cushing's "Lake Belt." The writer believes that Cushing's idea of complex infaulting or graben structure may be applied as a major factor in interpreting the Saranac basin. Cushing (1905, p. 427-29) believed that this faulting was of post-Cretaceous age and accompanied the warping and faulting of a Cretaceous peneplain. The upland surfaces of the floor of the infaulted block are thought by Cushing to be relics of the Cretaceous peneplain surface.

Cannon (1937, p. 88-93) has studied an area (Piseco Lake quadrangle) in the Adirondacks showing a similar topography and relation to faulting and has given a modified interpretation. The essential factors of his hypothesis are herewith summarized. There was initially a Precambrian peneplain covered with a sheet of early Paleozoic sediments. The peneplain with its veneer of flat-lying sediments was warped so as to acquire a general dome-shaped form at the end of Ordovician time during the Taconic disturbance. This was possibly accompanied by faulting in the Eastern Adirondacks and during the Appalachian revolution it is possible that the Adirondacks also experienced differential uplift and faulting. Erosion following the faulting stripped the Paleozoic cover from the surface of the pre-Potsdam peneplain on the displaced fault blocks and dissected their surface. The lines occupied by major valleys were determined chiefly by the form and slope of the peneplain on the various fault blocks and by lines of faulting. He interprets the present topography as essentially the exhumed and dissected surface of the pre-Potsdam peneplain, which had been warped and faulted.

A third hypothesis combining features of each of the solutions proposed by Cushing and Cannon seems probable to the writer as an explanation for the Saranac Intramontane Basin. This assumes that the entire Adirondack area was buried beneath a series of Paleozoic sediments. At some time or times after the end of the Ordovician and before the Tertiary period the Adirondacks were deformed to yield a generally dome-shaped mass with its eastern half profoundly block faulted. This highland mass was then eroded to yield a peneplain or a surface of only moderate relief. Many of the blocks of Paleozoic sediments infaulted as a result of the preceding period of deformation were below the new surface developed by erosion and thus preserved. The Paleozoic sediments were also preserved as a veneer on a far wider area of the outer part of the Adirondacks than is now the case. This surface was then again deformed into an asymmetrical dome. Major drainage systems were developed in conformity with the slope of the dome and therefore in a general radiate pattern. Subsequent forces of erosion thus had rocks of very inequal resistance upon which to work. The infaulted blocks of Paleozoic sediments and the synclinal complexes of Grenville metasediments were far more susceptible to relatively rapid erosion than the Precambrian igneous rocks and gneisses. As a result the former yielded lowlands and the latter remained as hills and mountains. Under this hypothesis the tops of the mountains around the Saranac Intramontane Basin would be interpreted as relics of a peneplain or moderately hilly upland surface (the Cretaceous peneplain of many geologists) which had maintained its altitude because of resistant bedrock. The floor of the basin would be the pre-Potsdam surface from which the overlying infaulted block of Paleozoic sediments had been removed because of its greater susceptibility to erosion. The pre-Potsdam surface of the basin has of course also been somewhat dissected by erosion and modified by the deposition of glacial drift. Such ridges as that including Boot Bay and Shingle Bay mountains and that of Katy mountain may represent subsidiary fault blocks within the major graben. The foregoing hypothesis would explain the fact that the headwaters of the Raquette and St Regis rivers cross the mountain range forming the northwest border of the Saranac basin. Their course would have been originally determined by the slope of the original dome northwest from the high mountain range of Mount Whiteface, Moose mountain and Mount Ampersand on the southeast. The subsequent erosion of the Paleozoic sediments within the Saranac graben would permit the development of the northwestward flowing Saranac river which thus transected and captured the initial former headwaters of the St Regis river which are assumed to have formerly crossed the entire width of the Saranac basin instead of merely entering it a short way as now.

The Adirondack mountains are rimmed by flat-lying early Paleozoic sediments warped up on the west and north, down-faulted on the east. No relics or direct evidence for the former presence of

Potsdam sandstone in place in the Saranac quadrangle, however, has been found and the south border of the present outcrop of the Potsdam sandstone lies somewhat less than 35 miles to the north and northwest of the town of Saranac Lake. In the adjoining Lake Placid quadrangle the local presence of large irregular slabs of Potsdam sandstone, however, has led Alling (Miller and Alling, 1925, p. 73) to suggest that it may have been in place nearby, and he finds a similar situation locally in the Mount Marcy quadrangle (Kemp, 1921, p. 65). The probability is very strong therefore that Potsdam sandstone formerly lay as a blanket over the entire Precambrian peneplain of the Adirondacks.

There is independent evidence for the existence of faults in certain

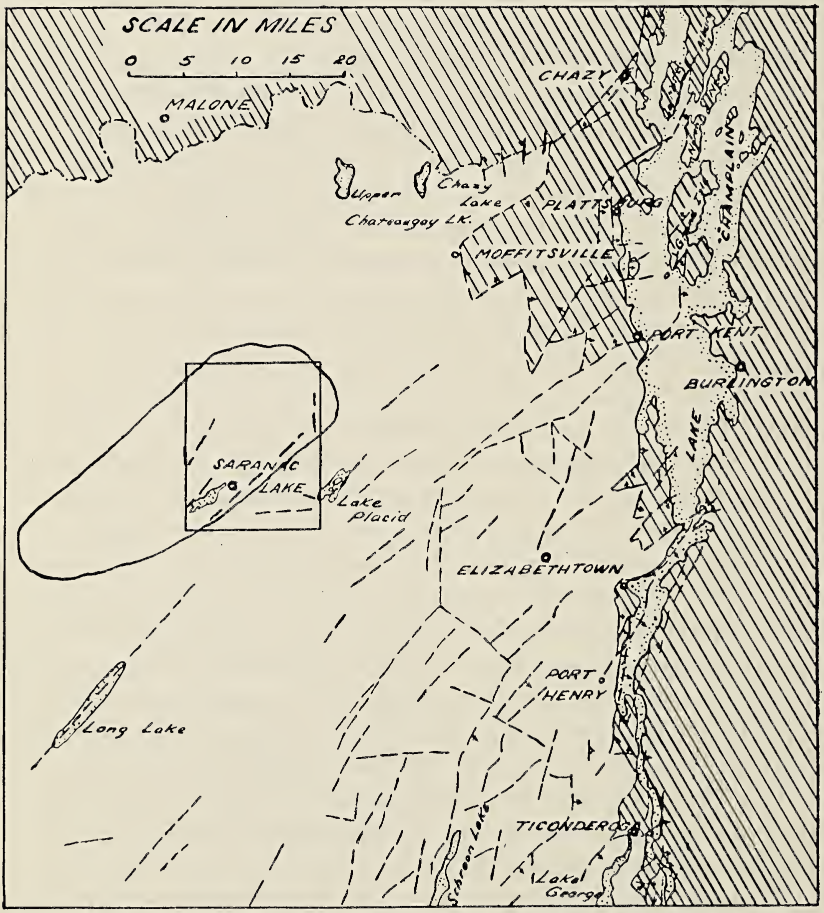


Figure 5—Map showing fault lines, known and inferred in Northeastern Adirondacks. Modified after map by Quinn. Lined area is Paleozoic sediments. Solid elliptical line outlines the area of Saranac Intramontane Basin.

discordances of structural relationships within the bedrock of the Saranac quadrangle. So much of the quadrangle in critical localities is covered with glacial drift, however, that direct evidence for faults along the borders of the depressed area have not been found. The presence of strong northeast striking faults of normal type in the eastern Adirondacks along Lake Champlain is, however, thoroughly proven (Quinn, 1933, p. 113-44) and is strongly suggested or locally proven throughout the east central Adirondacks. Figure 5 shows the location of the Saranac basin with respect to the faulting so far mapped. There are doubtless other faults which are present on unmapped quadrangles. Quinn (p. 120) states that "it is apparent that the faults trend in two main directions, northeast-southwest and north-south. There are some also which strike northwest-southeast, and a few which strike east-west." A grabenlike structure with down dropping along faults on three sides, and with Potsdam sandstone still occupying the infaulted block is shown northeast of Moffitsville. The Saranac basin may similarly be the product of a graben structure once occupied by the sandstone which has since been wholly eroded to leave the basin area. The total removal of the sandstone from the basin could not have been completed much before the Pleistocene for the floor of the graben has not been very deeply etched by erosion. The Moffitsville infaulted block lies near the northwest border of the major-faulted zone of the Adirondacks. The Saranac graben likewise lies along the northwest border for there is little evidence of faulting in the rocks to the northwest.

There is thus agreement between Cushing and the writer that the basin character of the Saranac area is the product of infaulting.[1] The question is as to whether the general level of the present surface of the basin represents substantially an exhumed stripped peneplain surface of Precambrian age or a part of a peneplain surface of Cretaceous or some younger age.

GLACIAL GEOLOGY

General statement. The great mountains and the major hills and valleys of the quadrangle are the product of differential erosion in rocks of different degrees of resistance and structure preceding the period of invasion by the continental ice sheets, but most of the subordinate physical features such as drift veneer, sand plains, valley fill,

[1] Crowl (1950) has proposed that such areas as that under discussion represent a widespread lower erosion level or partial peneplain. It may well be that a younger erosion level has been superimposed upon a low area localized in the first place by erosion of relatively weak infaulted Paleozoic sediments to yield the Saranac Intramontane Basin.

lakes and many minor hillocks are features related to glaciation of Pleistocene age, and will be discussed first.

A geological reconnaissance map depicting the glacial features of most of the quadrangle, has been previously published by Alling (1919) and this, together with some modifications and additions is incorporated in the geologic map. This map is not accurate in detail but does not serve to exemplify the principles which are used in interpreting the glacial phenomena of the area.

In the Pleistocene, at a period of maximum intensity, the whole Adirondacks were buried under an ice cap which was part of a sheet continuous back to its center in Labrador. This ice sheet moved along the direction of the St Lawrence valley in that region, along the Champlain valley on the east and in a general southerly to southwesterly direction across the Adirondacks as a whole. The basal currents of the ice in the high mountain areas, were controlled by the larger features of the topography, as indicated by the south-southwesterly flow across the Saranac Intramontane Basin.

In other parts of the United States the succession of glacial deposits is such as to indicate that there were several pronounced advances and retreats of the ice caps during the Pleistocene. In Pennsylvania and New Jersey deeply weathered glacial deposits of older age than the last ice advance (Wisconsin) are found well beyond the fresh terminal moraine which marks the limit of southward advance of the Wisconsin sheet. The Adirondack region has thus doubtless been subjected to repeated successive glaciations but satisfactory evidence for only the last one, the Wisconsin, has been found.

The ice sheet with silt, sand, and boulders incorporated in it ground off the loose and disintegrated weathered material which covered the bedrock, rounded the hills, polished many surfaces, and locally scratched or striated the underlying rock parallel to the direction of ice movement. A striking feature of the Saranac quadrangle are the really huge boulders, pre-eminently anorthosite, which are found locally, particularly in the southern half of the quadrangle. These were broken off from the parent ledges through the alternate freezing and thawing of the basal ice within fractures of the bed rock, transported some distance, and left on the melting away of the ice cap. A very common rock among the cobbles and gravel are fragments of Potsdam sandstone whose present nearest outcrop is a score or more of miles to the north and northeast. It may also be noted that pebbles of this kind of rock are formed on top of Mount Ampersand whose altitude is about 2000 feet above the highest exposure of the sandstone, indicating that the pebbles were lifted to that amount by the ice as well as carried forward. Many other types of deposit are consequent upon the activities of the glacier such as till, kame moraines, eskers, and glacial lake terraces and beaches. The term "drift" is used as a general term to include all facies of the deposits formed directly from the ice or from streams and waters resulting directly from the presence or melting of the ice. The lake basins of the area are also wholly consequent upon irregular deposition of material in the valleys which locally blocked the drainage and upon the melting out of stagnant ice blocks and ice tongues buried beneath deposits of sand and gravel.

The superficial aspects of the bedrock topography have been markedly modified by the deposition of glacial drift and of deposits of sediment in extinct glacial lakes. The lower slopes of all hills and mountains are almost universally completely covered with a veneer of drift so that no outcrops of bedrock are exposed. The ground moraine is sandy and bouldery and no typical boulder clay has been noted.

The rocks at the top of Moose (St Armand) mountain and McKenzie (Saddleback) mountain are much shattered and on top of Scarface mountain they are locally wedged apart along joints so that there are deep gaping fissures. Such intense weathering is not found in the Adirondack hills of lower altitude and the surmise may be hazarded that it is a product of intense frost action during the slow withdrawal of the ice sheet.

Glacial striae. Only a few striae on the bedrock formed by the scratches of cobbles and boulders in the base of the ice and indicating the direction of motion of the ice have been noted on the quadrangle. Fortunately, however, they are strategically distributed and consistent in indicating a general west-southwest movement in the valleys throughout the quadrangle, except for the high mountain country of the southeast corner where no striae were noted. Most of the striae strike S. 60 W. but locally S. 45 W. as at Franklin Falls (Lake Placid quadrangle) and three and one-half miles north-northwest of Saranac Lake. All the striae were found in the lowlands and therefore show only the direction of motion of the lower ice which may or may not have been parallel to that of the upper ice at the time of formation. No striae were observed on top of the higher mountains where evidence for the direction of movement of the overriding ice independent of topography might be expected. It seems probable that at the time of maximum for the ice sheet the general flow of the upper ice was southerly (figure 6) whereas the lower part of the ice over the Saranac Intramontane Basin was turned by the

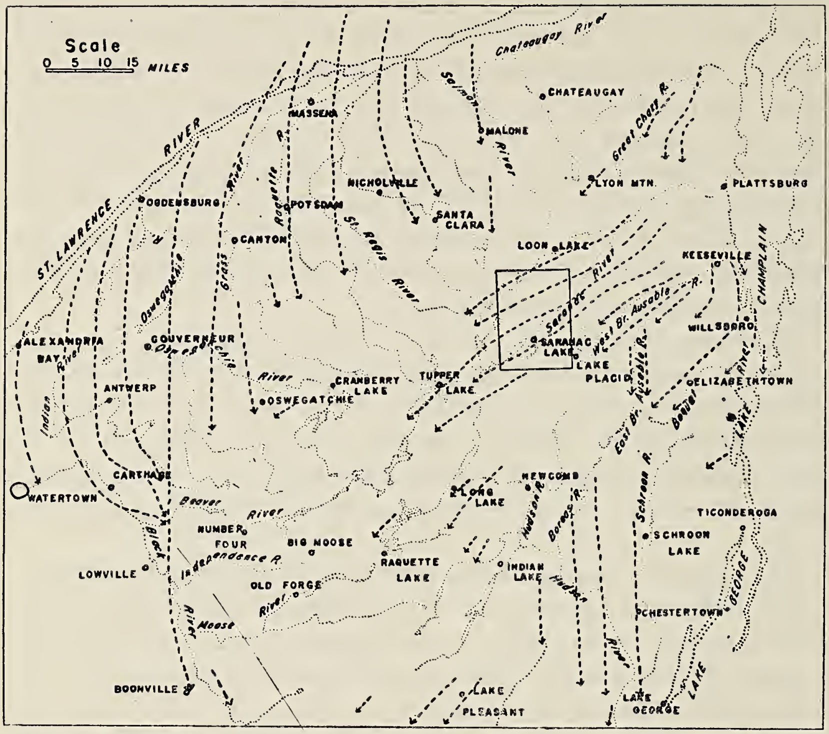


Figure 6—Sketch map showing direction of flow of Pleistocene ice as indicated by glacial striae.

high mountain block on the southeastern border so as to flow in general southwest parallel to the topography.

Glacial lakes. During the dissipation and melting of the ice cap, the mountain tops were uncovered in an early stage and lobes of ice occupied the valleys. These lobes temporarily blocked and dammed back the generally northeastward flowing drainage of the Saranac quadrangle and served to form temporary lakes between the ice and the highlands to the south into which were built beaches and deltas by streams coming off the higher lands and islands (figure 7). The surface materials of these deposits are usually bedded sand and gravel with a few disseminated boulders. The latter tend to become concentrated on the surface as a result of post-depositional erosion of the sand inclosing them and hence are now much more common on the surface than the composition of the underlying beds might at first suggest. Deposits made in such temporary glacial lakes are abundant in the valleys and on the flanks of many of the hills in the Saranac quadrangle. They have been studied and described so fully

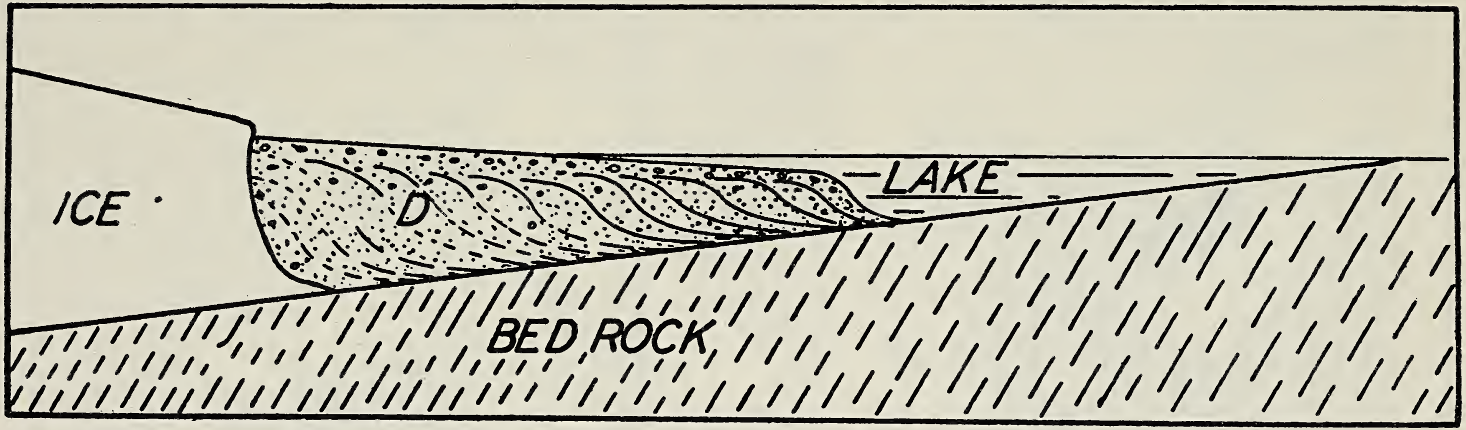


Figure 7—Sketch to show assumed mode of origin of certain Pleistocene deltas. Valley surface slopes to left, ice front during retreat temporarily stands stationary for a time and dams the river, and a lake is formed into which drainage from the ice builds a delta. Deltas are also being built into lake by streams from the land.

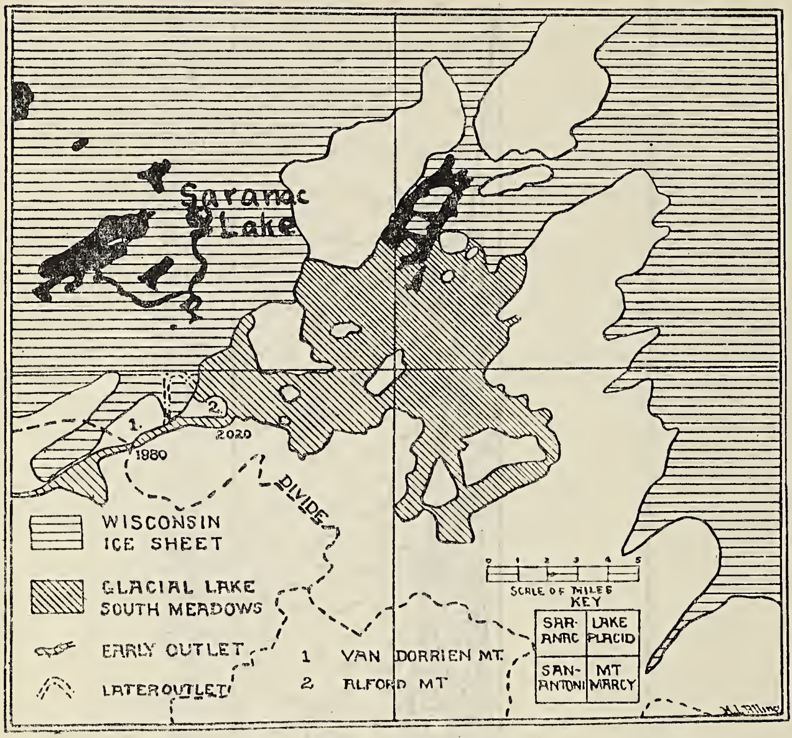


Figure 8—The Glacial lake succession in the Lake Placid-Saranac area. Stage one. The South Meadows lake, altitude 1950 to 2210 feet. After H. L. Alling.

by Alling (1919) that the following text is in large part quotations from his work.

South Meadows lake. The now extinct glacial South Meadows lake, named after South Meadows (Mount Marcy quadrangle) has been postulated by Alling (figure 8) to explain certain high-level sand deposits, some of which are present in the southeastern corner of the Saranac quadrangle. He (1919, p. 131-34) writes, "The highest definite level, as shown by sand plains, terraces and beaches, recognized by the writer in the Adirondacks is one ranging from 1950 to 2210 feet in altitude . . . The cause of the lake lay in the fact that normal drainage to the north was prevented by the ice that lay to the north, effectively damming the valleys. The writer considers that the glacier at this stage had three distinct lobes: one covered the Lake Clear-Saranac Lake district with its southern edge stretching from Ampersand mountain, through the spot where the village of Ray Brook is now situated to the northwestern slopes of Mount McKenzie. This lobe pushed a minor thumb into the depression where Ampersand lake is today. . . The South Meadows lake was of irregular shape, some ten miles long and wide, containing a number of islands, among which Mount Scarface and Seymour mountain may be mentioned. Its outlet has not as yet been definitely established but one very probable one (for the later stages) is offered as follows. It begins at the swamp just south of Mount Alford in the Santanoni quadrangle, on the Essex-Franklin county boundary line (altitude 2020 feet) . . . A number of beaches of unmistakable character exist on the shoulders of the Sentinel Range and on Scott's Cobble (both on the Lake Placid Quadrangle). The altitude of a series of them range from 2146 to 2209 feet. These figures, in all probability, represent the water levels during the early stages of the lake. (The outlet pass at head of Cascade lakes (Lake Placid Quadrangle) is 2180+ feet). Sand plains with altitudes around 1960 feet strongly indicate that the lake was undergoing constant lowering, perhaps the small ice lobe east of Ampersand mountain retreated and allowed escape (at lower levels) to the west. Remnants of the deposits of South Meadows lake are

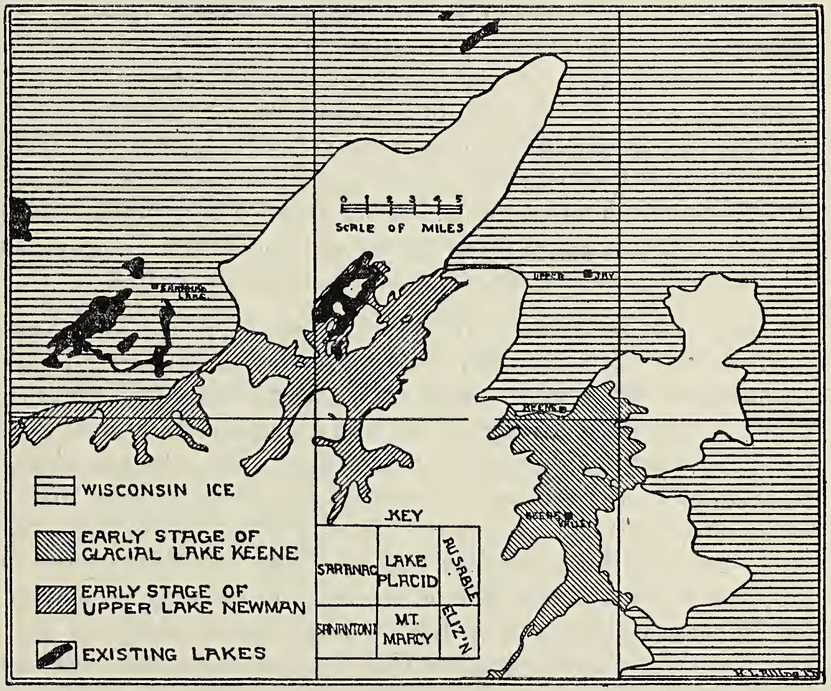


Figure 9—The Glacial lake succession in the Lake Placid-Saranac area. Stage two. The South Meadows lake was succeeded by the western section of Upper Lake Newman, altitude 1800 to 1895 feet. The ice lobe in the valley of the East Branch of the Ausable river had retreated since stage one to allow the Keene lake to accumulate. After H. L. Alling.

found surrounding Seymour mountain." Other possible remnants of delta deposits of this lake are found southwest of Whiteface.

Upper Lake Newman. The now extinct glacial lake, Upper Lake Newman, has been described by Alling (1919, p. 133-34) (figure 9) as follows: "With the gradual retreat of the ice and its constant shifting position, new and lower outlets were exposed. Succeeding the South Meadows lake, the western portion of Upper Lake Newman, as the writer proposes to call it was ushered in. As the present remnants are rather indefinite in character and its range is rather great (1800 to 1895 feet), the writer is not unmindful that stream filling, forming an outwash plain from the glacier, may be an alternative explanation; but in view of the fact that sand plains are found over considerable area confined within definite limits of range of altitude, they are assumed to represent a series of lake bottoms formed by a lake whose level was experiencing periodic lowering due to the downcutting of the controlling spillways. These spillways may have been the ice itself or a series of outlets which were over rock. Unfortunately, the outlets of the lake are not positively known but in all probability the drainage was to the west, similar to that of the South Meadows lake . . . well-preserved remnants can be seen in a number of places . . . A remnant is located about Harrietstown as a complete ring around the hill west of the village. A number of beaches of the lake have been located. One, well-preserved, is on the north side of the hill, one-half mile north of Harrietstown." The writer has found a ring of sand and gravel deposit at the appropriate level, also around the hill one and a half miles north of Bloomingdale Station.

Lower Lake Newman. Alling's description of Lower Lake Newman follows, "Soon, however, after the formation of Greater Upper Newman, the outlet was lowered by a shift of escapes so initiating a body of glacial waters (figure 10) with a range of levels from 1740 feet to 1780 feet altitude (at the present time). This lake was similar in character to the one just preceding it. It extended a little farther north and washed the slopes of the hills at a little lower altitude. The reason for subdividing the lake into the upper and lower phases is that there exists a distinct line of separation in the terraces, particularly in the neighborhood of John Brown's grave, along the west branch of the Ausable river. The Harrietstown beach above referred to is an excellent example. Its altitude is about 1800 feet and thus it belongs to the upper lake, but 20 feet or more below there is a fairly steep bank that is the critical feature . . . The name of the lake is derived from the town of Newman where well-preserved levels occur

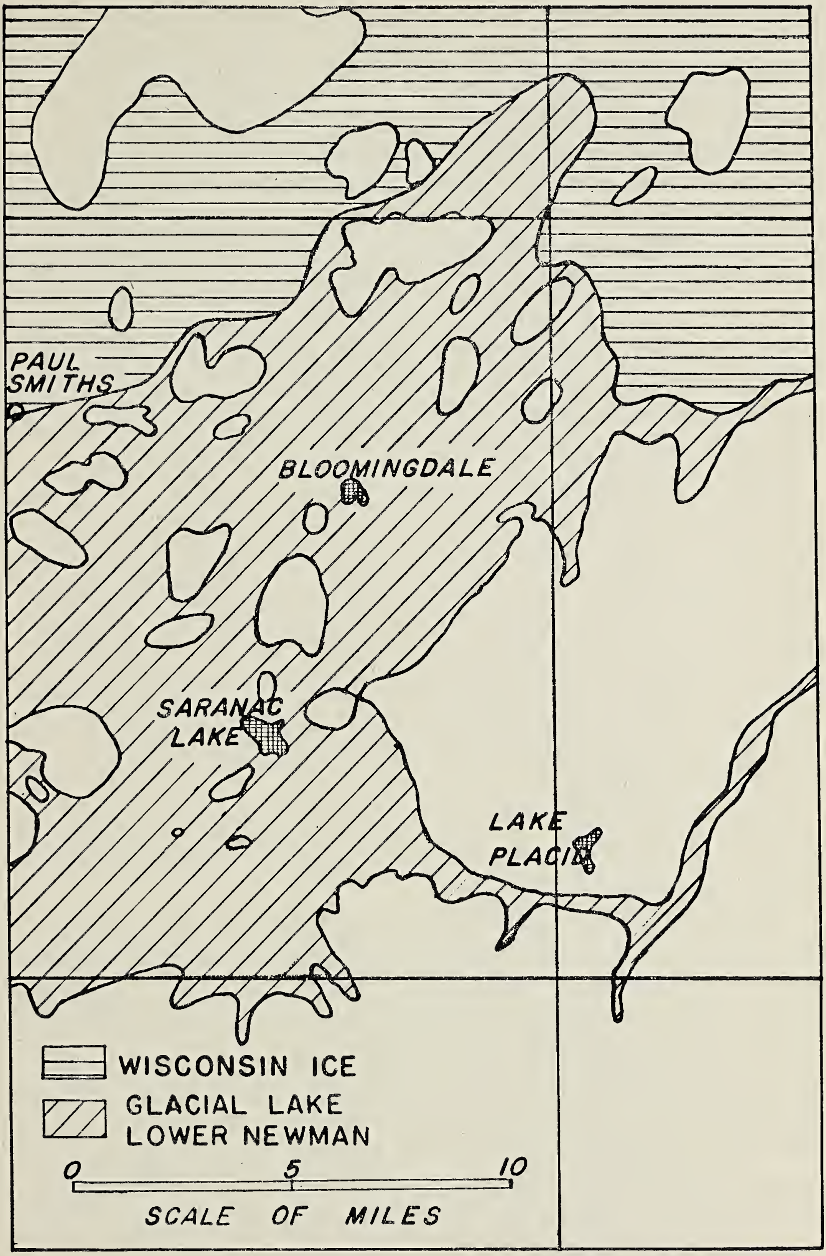


Figure 10—The Glacial lake succession in the Lake Placid-Saranac area. Stage three. The Keene lake was succeeded by the eastern section of Upper Lake Newman when the ice lobe in the valley of the Ausable river had retreated to uncover the Wilmington notch, allowing discharge to the west. Both eastern and western sections of Upper Lake Newman were succeeded by Lower Lake Newman, altitude 1740 to 1780 feet. Modified after H. L. Alling.

to the north and south. The drainage of Lower Newman is assumed to be westward. . . The three glacial lakes above described all had, apparently, westward drainage, but in the succeeding lakes (or group of lakes) we find a body of water whose outlets were to the east."

About one and one-half miles northeast of Vermontville there is a sand plain at an altitude of about 1700-1720 feet. The north border is a steep slope to a lower level with very uneven topography of the kind commonly found at the edge of an ice lobe. This suggests that the sand plain was built out into a lake at the edge of an ice tongue. Other patches of sand and gravel deposit at this level occur to the north. Alling, however, in his studies of extinct glacial lakes in this region has not recognized one of this altitude. Only more detailed field study can serve to elucidate the problem. Meanwhile the deposits at this level have been mapped with those of Lower Lake Newman.

Saranac glacial waters. Alling (1919, p. 135-36) states that, "The series of sand plains, terraces etc. that come under this head have such a wide range (1450 to 1660 feet) that they must have been produced by a series of glacial lakes, or by deposition by aggrading streams which no longer exist or by both." Doctor Cushing is of the opinion that "these sands were probably deposited as deltas in a large and irregular, shallow lake found back of the ice which occupied the 'Lake Belt' during its slow retreat north, the material being furnished by the subglacial and englacial streams flowing into the lake at the ice margin."

As nearly two-thirds of the Saranac sheet exhibits terraces and sand plains of this level, it was proposed that the name "Saranac glacial waters" be applied to these levels.

Not all the areas indicated upon the glacial map were covered by the waters of this series of lakes. Some portions represent outwash plains from the glacier, deposited by the overburdened aggrading streams from the melting ice, or deltas in standing waters, the surface of which in many places, was above the water level. Such a case is shown in the northern portion of the great sand plain that stretches from Lake Clear (Saranac) Junction north to Paul Smiths' station. The district about the junction was probably under water, but the northern district was a delta lying just under or above the surface. The contours, in their concentric sweeps, clearly show this. Alling (1919) has also written,

"When the outlets of the Saranac glacial waters are considered we find that we deal with a bit of glacial geology that is intensely interesting, but unfortunately the district is quite removed from this area. Nevertheless, a short account is here given. Thirty-three miles directly east of Lake Clear, in a rather inaccessible country, in the center of the Ausable quadrangle, there exists a long glacial channel running south a distance of some nine miles with a dozen side outlets to the east that were successively opened up by an ice lobe that lay farther to the east. The higher spillways are to the south which furnished the escape for the higher levels; but as the lobe retreated northward lower and lower outlets to the north were opened. In several of these side outlet channels (fossil) or abandoned falls and cataracts exist today entirely void of water. The channels are very impressive and furnish positive evidence of the former existence and nature of these levels. They are waterworn by the heavy drainage that eventually found its way southward in the Hudson-Champlain depression."

Post-lacustrine upwarp. Terraces, sand plains, and beaches interpreted as having been formed under marine conditions occur locally along the valleys of the Hudson river, Lake Champlain and the St Lawrence. These are found now at increasingly higher altitudes from south of New York to the northernmost Adirondacks and are explained by Fairchild (1919) as a product of upwarping and uplifting subsequent to the disappearance of the ice from the region and the following marine stage for the valleys cited. The lines of equal uplift (isobases) for this warping strike about N. 70 W. The amount of upward tilt for the Saranac area, at right angles to the isobases averages about 2.85 feet a mile, declining south-southwestward. Fairchild's data makes the total amount of uplift for the vicinity of the city of Saranac Lake about 600 feet. In other words the 600 foot isobase would pass through Saranac Lake. Alling (Kemp and Alling, 1925, p. 94, 95), however, believes that this gives only the amount of uplift that prevailed during and after the marine stage and that there was an additional uplift during a preceding earlier stage while the ice was in the later stages of disappearance from the Adirondacks and when the higher series of glacial lakes were being formed. He, therefore, believes that the total post-lacustrine uplift is somewhat greater than that estimated by Fairchild. There is no question, however, as to the validity of the concept of post-lacustrine uplift but only a problem as to the absolute amount. This means that while the ice sheet covered the Adirondacks the Saranac area was in general over 600 feet lower in altitude than it is now. The upwarping also results in delta surfaces which had formed at the same altitude at the same lake level surface now being as much as 50 feet higher at the extreme northeast corner of the quadrangle as compared with the extreme southwest corner.

Kame moraines. As has been noted, during the dissipation of the ice cap, the hills were uncovered first and an irregular network of ice lay among the hills as valley lobes or locally as relic remnants isolated from continuity with the lobes. Along the borders of the ice, the silt, sand, gravel and boulders of the ice were dropped as a band of submarginal drift in most irregular fashion to form single hillocks or kames, and also belts of kames with intervening depressions or kettle holes constituting a kame moraine. The great irregularity in thickness of the deposits of a kame moraine may result from original unevenness of distribution of debris within the ice, local fluctuating movements of the front of the ice, ice well and crevasse fillings, and local burial of portions of the ice front by debris (figure 11) followed by subsequent melting of the ice and slumping of the overburden. Local sheets of ice buried beneath sand and gravel in front of the main glacier is a common phenomenon of modern glaciers which are in a stage of retreat. The kame moraines of the Saranac area were all deposited when the ice front was bordered by the water of temporary glacial lakes. Hence the material of which they are composed is more or less stratified and it is frequently difficult to tell whether a given deposit is a kame moraine, a glacial lake delta or beach or an esker. An excellent example of a kame moraine may be found in the area around Loon pond. This consists of a complex assortment of conical hills and ridges of sand and gravel interspersed with depressions and kettles (note depression contours and small pond basins). Another well-defined kame area is along the road to Kiwassa lake. The Rainbow Lake esker is associated with and locally gives place to kame moraine. The Saranac esker likewise is associated with kame moraine, though not well-developed except locally as southwest of Oseetah lake.

Eskers. Eskers are irregular winding ridges of gravel and sand commonly broken and discontinuous with a form which often leads them to be called "embankments," "hogbacks" or "horsebacks." They are interpreted as river deposits formed primarily in tunnels within and at the base of the ice sheet. They are commonly parallel to the general direction of motion of the ice and may be arranged in tributary systems similar to those characteristic of normal stream drainage patterns.

Two well-defined eskers are present in the Saranac area. One lies in the valley of Rainbow lake, the other in general along or near the Saranac River drainage. The Rainbow esker (figure 12) is for part of its length a double one with the western ridge being the most perfect. The latter splits the lake down the middle into the Inlet and Clear pond on one side and Rainbow lake on the other. It is as fine an example of an esker as is commonly found and an excellent view of it may be had from the lookout tower of the Adirondack-Florida School on top of

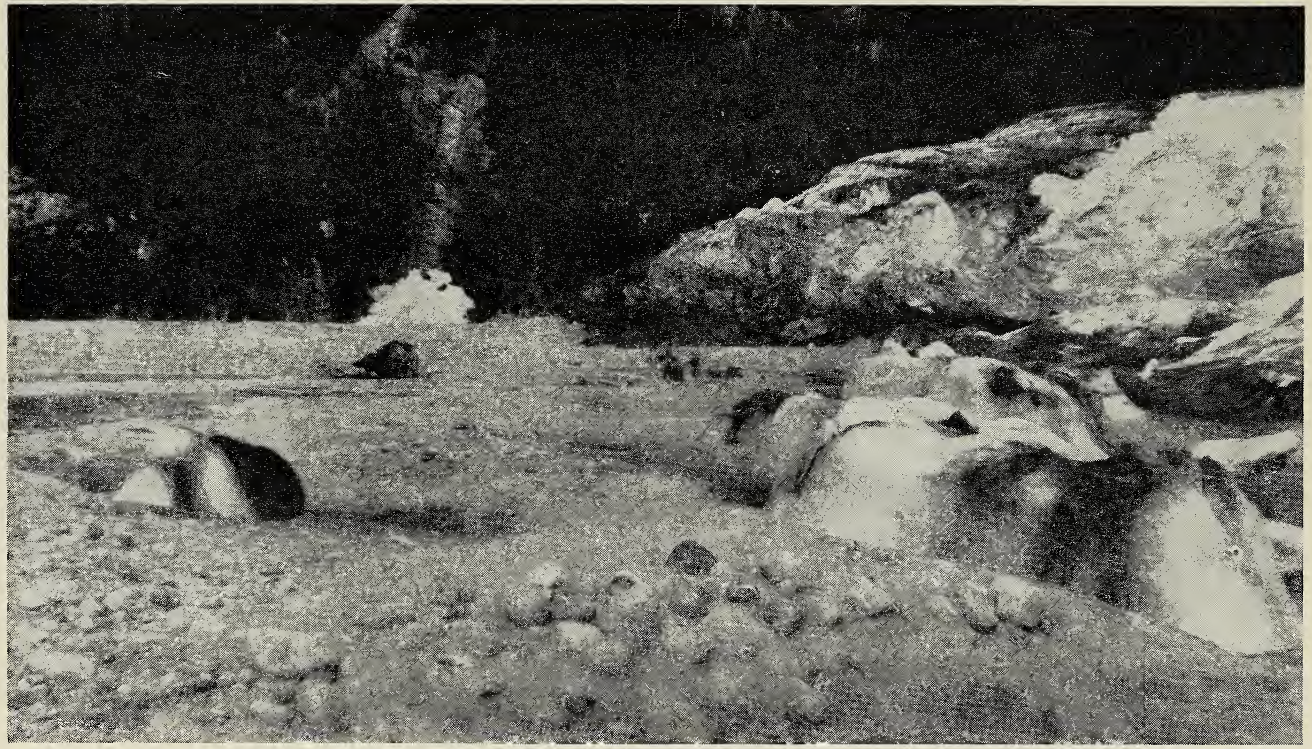


Figure 11—Front of Baird glacier, Thomas bay, Alaska. Ice blocks in front of glacier are partly buried beneath outwash plain of sand and gravel. Photograph by A. F. Buddington, U. S. Geological Survey.

Figure 12—Rainbow esker between Rainbow lake and Clear pond. View looking south from observation tower of Adirondack-Florida School. Photograph by Adirondack-Florida School.

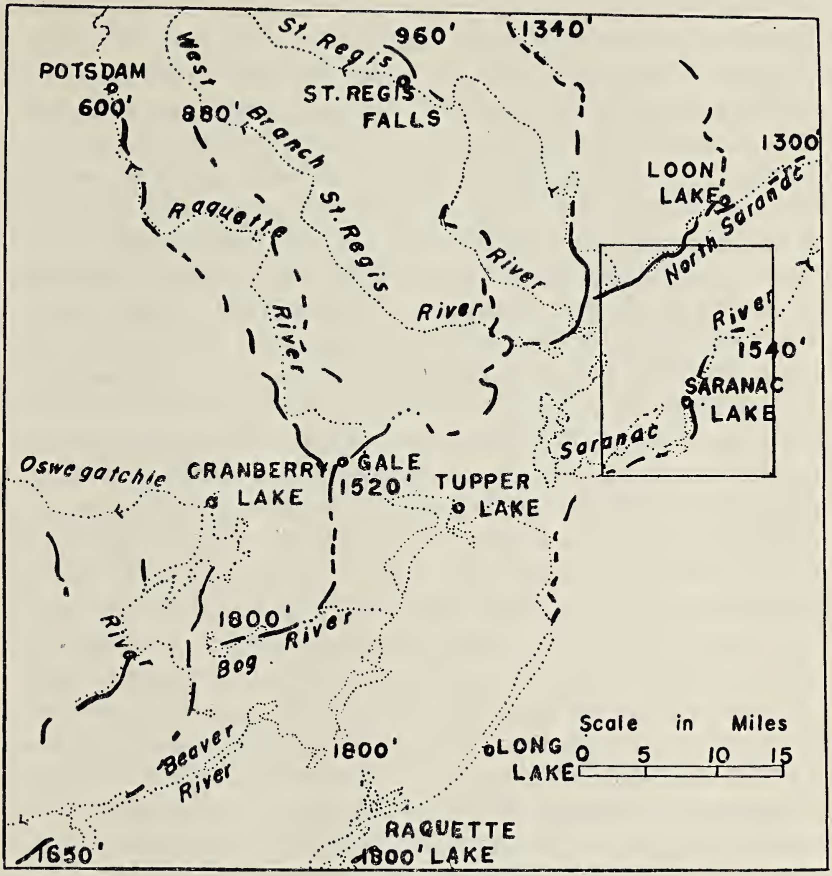


Figure 13—Skech map showing relationships of eskers on Saranac quadrangle to those in adjoining territory (modified after Chadwick). Arrows show direction of present drainage.

the hill west northwest of Square pond. The other esker lies just north of the railroad and is not so distinctive. Perhaps the twin eskers represent tunnels occupied by the drainage at different times, a shift of channel, or they may be two separate channels as in a braided stream. The Rainbow Lake esker is but a small part of an esker system which has a pattern similar to that of normal stream drainage (figure 13) except that the tributaries all enter from the north. From the extreme northeast to the southwest the esker of which the Rainbow is a part is about 85 miles long, and it is probable that the northeast end lies beyond the area of the sketch. It extends almost across the entire mass of the Adirondack mountains and may therefore appropriately be called the Adirondack esker. The manner in which the tributaries join indicates that the drainage forming the main esker flowed southwest. This means that starting at the extreme northeast at an altitude of about 1300 feet the main esker rises along the valley of the West Branch of the Saranac river, crosses the very low divides between the tributaries of the St Regis river near their heads, crosses the St Regis river at an altitude of 1620 feet and the Raquette river at an altitude of about 1500 feet, and reaches an altitude of 1800 feet where it crosses the divide between the Bog river (of the Raquette River watershed) and the headwaters of the Oswegatchie river. Thence it crosses the divide between the Oswegatchie and the Beaver river at a maximum altitude of 1860 feet and is at an altitude of 1600 feet at the southwest corner of the area shown in the sketch. The esker thus rises and falls in altitude in accordance with the underlying relief, quite in contrast to a normal river. The esker rises a maximum of 560 feet as the land now lies but since the land has risen increasingly to the north since the retreat of the ice the figure of 560 would have to be increased by at least 150 feet making a total rise of over 700 feet at the time the esker was formed. Uphill flow is possible where the rivers are flowing in tunnels inclosed in the ice and under hydrostatic head, but it is doubtful if any such river was actually flowing uphill for more than a short distance at any one period of time. All the tributary eskers rise upstream opposite to the present drainage. The esker coming southeast from Potsdam rises from an altitude of 600 feet to over 1500 feet at the junction at Massawepie lake. The crest of the Rainbow esker in its northern part is gently undulatory but at the southwest end of the lake where the eskers along the north and south sides of the lake join the width is broad and the surface is hummocky and full of depressions.

The Saranac esker is well-developed across the Saranac quadrangle but is not so marked a feature of the Adirondacks as a whole as the Adirondack esker. It lies just to the north and west of the Saranac river from the east side of the quadrangle to Saranac lake where the river crosses it. The esker then lies to the east and south of the river and the lakes. The large gravel pit three miles north-northeast of Saranac lake and the several gravel pits in the east part of the city of Saranac Lake are all in this esker. The cuts show the esker to be composed of stratified sand and gravel. The gravel in some beds is composed of cobbles. To the southwest of the Saranac Lake quadrangle the extension of the esker appears to be indicated by the character of the topography along the east side of Stony Creek ponds and along the line of trail from Raquette falls to Cold river on the Long Lake quadrangle.

The eskers lie exclusively in the bottom part of valleys or along divides between streams which are uniformly low and gentle and parts of valleylike forms. The Adirondack esker conforms with major topographic depressions parallel to the mountain ranges except where it crosses them for several miles on a due north course from Gale to the Bog river. The problem arises as to the factors which localized the course of this major esker. Inspection of the direction of flow of the basal ice as indicated by the striae (figure 6) show that at the north there was a generally southerly flow but that along the general belt of the Saranac Intramontane Basin and in a continuing zone to the northeast and southwest the flow was to the southwest. It may be recalled also that the Saranac Basin is bordered by a mountain range on the northwest and a very high mountain range on the southeast. A generalized topographic map of the Adirondacks shows also that there is a major topographic depression extending from the northeast to southwest parallel to the Saranac river on its North branch, the Saranac and St Regis lakes, the Tupper lakes, and Beaver River flow. Under such conditions it seems highly probable that in a late active phase of the ice sheet there was a concentration of ice flow to the southwestward along this belt which was reflected by a corresponding marked depression or trough in the surface of the ice sheet. The surface of the ice sheet to the northwest might be expected to have a southerly slope corresponding to the direction of the striae. In detail its surface might also be expected to have southerly trending depressions as a reflection of underlying topographic lows with a similar orientation. Long and pronounced depressions, presumably a reflection of deep topographic valleys, have been described by many authors (see Bretz, 1935, p. 239), as present in the present Greenland Ice caps. The great fiords may be traced far back into the inland ice by such depressions. The writer conceives that such depressions of the surface of the ice sheet were one factor in fixing the gross pattern of the esker system. The basal part of the ice acquires a layering roughly conformable with the underlying topography and this too would serve as a factor in localizing the position of the esker forming streams. The actual topographic surface would of course serve to localize the position of streams which were flowing on it, but there are so many inconsistencies between the topography and the eskers that it seems impossible that this could directly be the major cause. There will of course be other subordinate factors such as fissures in the ice. Wilson (1939, p. 127) has postulated the following origin for an esker system in Northwest Territory of Canada similar to those of the Adirondacks. "The streams that formed the eskers are of interest. Their dependence on the slope of the top of the ice and their dendritic pattern show that they started to flow on top of the ice. As they found their way to lower levels there was little debris in the clean ice for them to pick up until they reached the bottom in drift-covered areas . . . the streams flowed upon or within the clean ice until nearly at the edge of the ice sheet before cutting to the bottom. Then at each stage in the recession of the ice sheet, as the streams reached the ground the drift there was reworked . . . Not until the rising slope of the underlying land surface brought the basal layer of dirty ice high enough to intersect the stream bed could the water begin to pick up material and form an esker."

Lake belt and lakes. Lakes are of frequent occurrence throughout the Adirondacks but they are especially abundant within a central belt about 18-30 miles wide and 75 miles long, extending northeast from Old Forge and Piseco lake to Loon lake. Most of the Saranac quadrangle lies within this belt. The "Lake Belt" lies at the headwaters and upper reaches of several of the major rivers of the Adirondacks (Saranac, St Regis, Raquette, Grass, Beaver, Moose and Hudson). The lakes are thus clustered in greatest number along the divides and upper reaches of major streams, and do not differ greatly in altitude (almost entirely between 1500 and 1900 feet, only four out of 64 of the lakes of area more than 0.4 square mile being over 1900 feet with a maximum of 2187 feet). The lakes are the product of irregular deposition of glacial and glacio-fluviatile drift in the valleys. In many examples the overflow streams from the lakes have encountered rock in cutting down through the moraine or sands and gravels which blocked the valleys. Were it not for these rock ledges the outlets of a number of the lakes would have been lowered so as to drain them before this. The level of Upper Saranac lake is maintained by the ledge of anorthosite over which its outlet pours at the Bartlett club house; Middle Saranac lake is held by an anorthosite ledge at the site of the present locks, Lower Saranac lake by the ledges south of the village.

The lake belt as a whole lies along the zone where the glacial striae (figure 6) strike southwest and where it is probable there was a concentration of ice flow. The lake basins, in so far as they are the result of local intense erosion of rock therefore find a reasonable interpretation as the product of ice sculpture beneath a relatively faster flowing ice current.

The lake basins of the Saranac quadrangle have several different origins though all are related to phenomena connected with the Pleistocene ice sheet. The Lower Saranac Lake basin is dammed by a deposit of sand at the northeast end and the outlet is from the side of the lake.

The lake is bordered by rock cliffs and it is probable that its basin though in part due to natural damming of a river valley is in part due to direct local erosion of the bed rock by an ice tongue. The basin occupied by Lake Flower is a former valley dammed by kame moraine at the present outlet. The basin of Colby pond is due to natural damming by the same local excessive deposition of material as Lakes Flower and Lower Saranac. Moose and McKenzie ponds are likewise due to damming of tributary valleys by local extra deep deposition of drift. Lake Clear and McCauley ponds lie in basins in the deposits laid down on the floor of Glacial Greater Lake Saranac. Alling (1919, p. 139) has given the following hypothesis for the origin of Lake Clear.

The great sand plain left by the Saranac waters about the Junction, is without question fairly thick and buries a fault-line valley that may have been a preglacial stream-course. The rock bottom of this valley may have been deepened at the spot where Lake Clear is now situated by virtue of the (local) weakness of the rocks enabling the glacier to hollow out a basin. At this point, when the glacier was melting it perhaps left a block of ice in the depression which eventually became buried by the outwash and lake sands. The block was thus placed in a natural refrigerator and hence remained unmelted long after the withdrawal of the ice sheet and the draining away of the Saranac waters. In time, however, it melted, lowering the surface, forming a depression which became filled with rain water, and marking the beginning of Lake Clear.

Osgood pond, Jones pond, Inlet, Rainbow lake, Clear pond, Loon pond, Square pond and Oregon pond are all the product of irregular deposition by glacio-fluviatile material beneath and at the edge of an ice tongue which lay in a preglacial valley from Paul Smiths to north of Onchiota and are very obviously related to the esker ridges. These lake basins may all have been the site of stagnant ice blocks and tongues which protected the site occupied by them from much deposition and left a depression where they melted.

In the southern part of the quadrangle, Owl pond, Pine pond and the pond southwest of Seymour mountain are all excellent examples of lakes in basins in a pitted sand plain formed by isolation of relic ice blocks buried in the sand plains and subsequently melted. The kettle holes marked by depression contours in sand plains and kame moraines are similarly the product of the melting out of ice blocks isolated as relics from the main ice sheet.

Cirques and tarns. Three small amphitheaterlike basins sculptured in the solid rock of the ridge of McKenzie and Moose mountains are particularly interesting as a type found exclusively in the very high mountains of the Adirondacks. Two of them have basin-shaped floors, the southernmost is occupied by a small pond, and the one to the north by a swamp. Both have a rock ridge across the front which serves as a raised lip to the basin behind. The walls of all three amphitheaters are exceptionally steep. They are at altitudes of about 2830, 2960 and 3060 feet respectively and lie on the southeast slope of the mountain. These basins are interpreted as "cirques" and are a product of erosion by mountain glaciers at the heads of the valleys occupied by them. Johnson (1917, p. 548-49) has concluded that the cirques of the Adirondack mountains are the product of local glaciers developed after the withdrawal of the main ice sheet. The lakes in the small cirque basins are called tarns.

PETROGRAPHY

GRENVILLE ROCKS

The Grenville rocks are exposed largely in Mount Pisgah, the hill west of Bloomingdale and on the flanks of the ridge which extends from Mount Pisgah to Bloomingdale. A small area is exposed in the extreme southeast corner of the quadrangle and a couple of narrow bands are included in the Loon Lake complex in the northeast corner.

The Grenville rocks comprise predominantly coarsely crystalline, glassy white quartzites in part thin layered or thin laminated with pyroxene granulite and light-colored pyroxene-feldspar gneisses. Subordinate facies are coarsely crystalline limestone, dark amphibolite in part coarsely garnetiferous, pyroxene granulites, phlogopitic and feldspathic quartzites with thin interlayers of garnet mica schist, and quartzitic rocks with disseminated garnets. The pyroxene granulites are predominantly white but locally green. The pyroxene-feldspar gneisses in part carry disseminted pyrite and weather rusty brown. The quartzites commonly carry accessory diopside, rounded grains of sphene, and a trifle of apatite and phlogopite. They are excellently exposed on Mount Pisgah together with pyroxene granulites. The rock near the Bloomingdale reservoir on top of the hill to the west of the town is a feldspathic quartzite with disseminated pyrite and pyrrhotite. The feldspar is perthite. The dark bed so conspicuous in the cliffs at the south end of Mount Pisgah consists of augite and andesine with abundant rounded grains of sphene. It is underlain by a migmatitic pyroxenic quartzite with considerable arteritic injection of thin-granite veinings. Limestone is exposed near the foot of the ridge just west of the gravel pit one and three-fourths miles north of Trudeau. It contains nodules composed of scapolite, phlogopite and brown tourmaline. The limestone at the south end of the hill in the southeast corner of the quadrangle contains numerous granite pegmatite nodules up to a foot in length. Beautiful blue apatite crystals are conspicuous in these nodules. Microcline is also disseminated in the limestone here. The hill two and one-fourth miles southwest of Bloomingdale and two miles a little south of true east of Harrietstown carries layers of perthite gneiss with subordinate pyroxene, phlogopite and quartz, and accessory coarse flakes of crystalline graphite. White quartzitic beds overlie the phlogopitic feldspathic gneisses. The composition of most of the Grenville rocks is not wholly consistent with a normal series of sediments and it seems certain that they have nearly all been more or less modified by the agency of solutions given off by the intrusions, probably pre-eminently by the associated granite.

ANORTHOSITIC COMPLEX

Introduction. The term anorthositic series or anorthositic complex is here used for a group of rocks widely variable in composition but from their relationships interpreted as having a common origin. They comprise ultramafic layers (90-100 per cent mafic minerals), mafic gabbro and mafic norite (65-77½ per cent mafic minerals), norite and gabbro (35-65 per cent mafic minerals), anorthositic gabbro and anorthositic norite (22½-35 per cent mafic minerals), noritic or gabbroic anorthosite (10-22½ per cent mafic minerals), anorthosite (0-10 per cent mafic minerals), and minor gabbro-pegmatite dikes. Anorthosite with subordinate gabbroic or noritic anorthosite are the predominant rocks. All members of the series belong in general to saturated types. Quartz never forms more than a few tenths of a per cent in the normal anorthositic rocks and magnesian-olivine has never been found in rocks positively identified as belonging to the anorthositic series.

Two facies of the anorthositic rocks have been defined, named and differentiated on published geologic maps. One facies is the Whiteface, originally described by Kemp (1898, p. 57-58) and named from the anorthositic rock of Whiteface mountain. It is largely restricted to the borders of the anorthositic massif or to bands closely involved with Grenville layers and inclusions, characterized by a medium-granular texture, more dark silicates than the core of the massif, a milky-white or nearly white feldspar and usually a distinct foliation. It frequently contains a few scattered phenocrystlike crystals or porphyroclasts of blue-gray plagioclase. The predominant rock is a gabbroic anorthosite, but rocks mapped as Whiteface facies include true anorthosite of typical Marcy type, gabbroic anorthosite and anorthositic gabbro.

Miller (1919, p. 17-20) named the rock characteristic of the core of the anorthosite massif the Marcy anorthosite and described it as typically a bluish gray, coarse to very coarse-grained anorthosite with less than 10 per cent dark minerals, though locally these may rise to 15 to 25 per cent, much of it with indistinct foliation or none at all, and with a variable amount of light gray to light greenish gray groundmass consisting of granulated plagioclase which may exceed in quantity the uncrushed cores though normally it is subordinate.

The terms Marcy and Whiteface have thus been used in the sense of formation names rather than of closely defined rock-types, and it is with this significance that the terms will be used in this report.

Marcy facies. Excellent exposures of only slightly deformed Marcy anorthosite are afforded by the road cuts just off the southwest corner of the Saranac quadrangle and on the bare top of Mount Ampersand. At the latter locality the anorthosite has a well-defined primary gneissoid flow structure. The grain is very coarse; the andesine plagioclase crystals are commonly two to three inches in length with sparse larger crystals up to a foot in length. There are local gabbroic anorthosite bands. In the road cuts southwest of the foot of the Ampersand trail the fresh anorthosite appears to be undeformed with poor to well-defined flow structure, but the weathered surfaces show that there has been internal movement which has granulated the feldspars so that there is a small amount of groundmass and the rock is a mortar gneiss. The andesine crystals in general vary from one to three inches in length, commonly two to three inches with here and there phenocrysts up to 12 inches in size. There are also local schlieren of very coarse anorthosite with the plagioclase averaging at least several inches in diameter. The largest andesine crystal seen was 22 inches long and six inches wide forming part of a very coarse pegmatitic facies with disseminated sulphides and a haphazard texture in contrast to the flow structure of the dominant rock. This exposure is about two miles south of Lake Clear just west of the border of the Saranac quadrangle. A few gabbro-pegmatite seams one to a few inches in diameter are present.

The plagioclase of the Marcy facies is a calcic andesine and varies from An_{40} to An_{49} and averages about An_{45}. A little potash feldspar occurs as antiperthitic intergrowths in the andesine. The pyroxenes comprise both augite and hypersthene and the ratio of one to the other varies widely. Accessory minerals include ilmenite, magnetite and apatite. A trifle of hornblende or biotite is present locally and is secondary after the primary mafic minerals. A little garnet is present locally where there has been metamorphic reconstitution. It does not occur in typical Marcy anorthosite of the cores of the great domes.

The Marcy anorthosite in general varies from a mortar gneiss without a foliation sufficiently well-developed to permit structure determination as in the vicinity of Boot Bay mountain, through mortar gneiss with an ill-defined foliation, to augen gneiss with a well-defined foliation. There are local bands within the mortar gneiss having a primary flow structure. The rock forming the islands and shores of Saranac lake and the country to the northwest is predominantly a very coarse Marcy anorthosite-mortar gneiss in which no foliation can be observed, with local bands of augen gneiss. North of Shingle bay the anorthosite mortar gneiss has interbands of augen and granoblastic gneiss and also some gabboric anorthosite layers. The granulated bands at a number of places have a sharp border against the mortar gneiss which is at an angle to the foliation. Shingle Bay mountain is composed of a strongly-foliated much-granulated rock with about 10 per cent mafic minerals, is garnetiferous, and has 10-25 per cent augen. The rock between the city of Saranac Lake and the outlet of Saranac river from Lower Saranac lake consists of coarse anorthosite with mortar structure interbanded with anorthosite-augen gneiss. In the mortar gneiss the andesine averages 2 inches in length and there are scattered larger crystals up to nine inches. The andesine crystals have in general a random arrangement. The bands of augen gneiss appear to have rather sharp contacts with those consisting of mortar gneiss. There are sparse gabbroic anorthosite bands, usually equiangular in structure.

Within the Marcy anorthosite there is a belt about a mile wide and six miles long within which the rocks are in general quite thoroughly granulated with some mafic bands and more garnetiferous in composition than normal Marcy facies. This belt includes the ridge southwest of Loon bay and strikes a little east of north through Shingle Bay mountain to and including the outcrops on the railway for a mile west of McCauley pond. The belt is nearly at right angles to the general strike of the foliation of the normal Marcy facies and within the belt the foliation strikes north-northeast and dips gently to steeply to the east. The structure seems best interpreted as a very sharp bend of the foliation whose axis pitches gently to moderately to the east and within which the granulation has been exceptionally intense; a broad shear zone. Such sharp angular relations of the foliation are also found locally on a much smaller scale at several places.

TABLE 2

Mineral Composition of Anorthosite Series (Wt Per cent)

	ANDESINE	MICROCLINE	HYPERSTHENE	AUGITE	HORNBLENDE	BIOTITE	MAGNETITE AND ILMENITE	GARNET	QUARTZ	APATITE	SPHENE	CHLORITE, EPIDOTE, CARBONATE ETC.	PYRITE	SPINEL	OLIVINE
ANORTHOSITE															
1.....	93.5	.....	2.6	2.8	0.2	.....	0.5	0.2	.....	0.2	.....	.....	Tr.	.....	......
2.....	88.8	4.2	.....	0.9	1.1	.....	0.7	3.2	0.8	0.3	.....	.....	.....	.....	......
GABBROIC ANORTHOSITE															
3.....	81.4	2.0	2.7	7.8	.....	0.1	5	.....	0.3	0.7	.....	.....	.....	.....	......
4.....	77.2	5.1	.....	1.4	14.3	.....	0.3	0.5	0.4	0.7	.....	.....	.....	.....	......
ANORTHOSITIC GABBRO-NORITE															
5.....	72	.....	14.2	7.6	.....	1.6	4.5	.....	.....	.....	.....	.....	.....	.....	......
6.....	72.2	2.2	9.8	10.7	.....	.....	3.9	.....	.....	1.2	.....	.....	Tr.	.....	......
GABBRO, GABBRO-NORITE AND NORITE															
7.....	56.6	1.9	6.7	15.7	.....	.....	14.8	0.8	.....	3.5	.....	.....	.....	.....	......
8.....	59.9	3.7	20.9	7.0	.....	.....	7.1	.....	.....	0.8	.....	0.3	0.3	.....	......
9.....	45	2.7	1.6	16.8	.....	.....	15.1	13.5	0.3	5.0	.....	.....	.....	.....	......
10.....	46.3	1.5	10.8	11.7	....	......	12.5	11.9	.....	5.3	.....	.....	.....	.....	......
11.....	59.9	.....	5.5	22.6	.....	.....	9	3	.....	.....	.....	.....	.....	.....	......
12.....	53.6	.....	.....	6.0	.....	0.3	24.9	15.1	.....	0.1	.....	.....	.....	.....	......

MAFIC FACIES OF GABBRO, GABBRO-NORITE AND NORITE

13.....	29.8	2.3	14.4	11.0	27.5	.....	6.6	.....	0.3	7.8	.....	.....	0.3	.....	......
14.....	21.6	.....	24.7	31.5	0.7	.....	20.0	.....	.....	0.9	.....	.....	.0.7	.....	......
15.....	18	.....	37	14.0	.....	.....	14	10	.....	7	.....	.....	.....	.....	......
16.....	21.2	.....	9.7	50.0	.....	.....	15.4	3.4	.....	.....	.....	.....	0.3	.....	......
17.....	25	.....	1	9	.....	2	25	11	.....	9	.....	.....	.....	.....	18
ULTRAMAFIC FACIES															
18.....	9	.....	18	1	24	.....	37	2	.....	9	.....	.....	.....	.....	......
19.....	2.8	.....	19.2	41.7	.....	.....	35	0.3	.....	0.5	.....	.....	0.5	.....	......
20.....	4	.....	0.5	0.1	4	0.2	85.8	4.8	.....	.....	.....	.....	.....	0.6	......

1 Average of 20 thin sections of anorthositic rocks from outcrops along road from Saranac lake to Tupper lake.
2 Cut on railroad, one mile west of Saranac station.
3 West headland of Boot bay, Saranac lake.
4 Eastern part of Baker mountain.
5 One-quarter of a mile east of "lock" between Lower and Middle Saranac lakes.
6 Two miles southwest of Gabriels.
7 Two and three-tenths miles northeast of Lake Clear.
8 One and seven-tenths miles west of Gabriels.
9 One-half of a mile northeast of McCauley pond.
10 Three-fifths of a mile northeast of McCauley pond.
11 One mile northwest of Shingle bay, conformable layer in anorthosite.
12 One mile northwest of Shingle bay, conformable layer in anorthosite.
13 One mile west northwest of Gabriels, mafic gabbro, incloses blocks of anorthosite.
14 North end of Lake Clear, the mafic gabbro incloses blocks of anorthosite.
15 Three-fifths of a mile northeast of McCauley pond.
16 One mile northwest of Shingle bay, conformable layer in anorthosite.
17 Seven-tenths of a mile east of north end of McCauley pond.
18 Three-fourths of a mile east of north end of McCauley pond.
19 Three-fourths of a mile northwest of Shingle bay.
20 One-quarter of a mile east of lock between Lower and Middle Saranac lakes.

TABLE 3
Chemical Analyses and Norms of Members of Anorthositic Series*

	1	2	3	4	5	6	7	8
SiO_2	53.55	55.51	55.03	54.55	56.40	50.93	33.85	39.01
Al_2O_3	24.10	25.41	25.56	22.50	24.11	16.91	10.97	5.92
Fe_2O_3	1.24	.69	.75	1.31	.60	1.69	6.60	6.58
FeO	2.26	1.55	1.59	3.89	2.16	9.27	19.80	18.13
MgO	1.34	1.34	1.02	1.01	.41	5.25	4.80	10.65
CaO	9.64	9.36	9.56	7.81	8.06	8.34	8.73	9.90
Na_2O	4.62	4.84	4.67	4.61	5.01	3.13	1.98	.79
K_2O	.94	.94	1.09	1.93	1.93	1.09	.72	.15
H_2O^+	.41	.16	.28	.48	.35	.19	.55	.22
H_2O^-	.11	.06	.03	.08	.07	.01	.28	.05
CO_2	.15	•	.13	.14	•	.31	•	•
TiO_2	1.63	.21	.43	1.12	.44	2.54	7.43	8.18
P_2O_5	•	•	.09	.35	.25	.23	3.66	.07
S	•	•	.01	.03	•	•	•	•
MnO	•	•	•	•	.04	.17	.29	.34
	99.99	100.07	100.24	99.81	99.83	100.06	99.66	99.99

NORMS

Quartz	1.77	1.26	1.86	1.98	1.77	1.05	•	....
Orthoclase	5.56	5.56	6.67	11.12	11.12	6.67	4.45	.89
Albite	38.89	40.87	39.40	38.77	42.44	26.20	16.77	6.81
Anorthite	42.15	44.76	45.30	35.31	37.53	28.91	18.90	12.19
Diopside	3.72	1.36	•	.23	.71	7.55	2.34	29.67
Hypersthene	2.00	4.60	4.18	6.61	3.47	21.06	9.41	19.35
Olivine	•	•	•	•	•	•	15.42	5.62
Magnetite	1.97	1.00	1.05	1.86	.93	2.55	9.51	9.51
Ilmenite	3.04	.39	.84	2.13	.84	4.86	14.14	15.50
Apatite	•	•	.20	.84	.60	.54	8.57	.17
Calcite	.34	•	.30	.30	•	.70	•	....
Femics	10.73	6.96	6.27	11.67	5.95	26.02	59.39	79.82

* The data for this table with exception of No. 8 are taken from report by Buddington on Adirondack Igneous Rocks and their Metamorphism.

1 Anorthosite (Marcy type); road cut at southwest end of Lake Clear (St Regis quadrangle), one-fourth of a mile east of outlet of Lake Clear. Composed of coarse andesine (Ab_{55} An_{45}), augite and a trifle hypersthene. Analyst, A. Willman.

2 Anorthosite (Marcy type); road cut (old road) at extreme southwest corner of Saranac quadrangle. Composed of coarse andesine (Ab_{56} An_{44}) and hypersthene with a little augite and accessory magnetite, ilmenite and a trifle apatite. Analyst, A. Willman.

3 Anorthosite (Marcy facies); analysis of composite grab sample of 60 fragments from ten localities in core of St Regis-Marcy dome along road from Algonquin (Saranac quadrangle) to half a mile northwest of Rustic Lodge (St Regis quadrangle). Analyst, R. B. Ellestad. Modal mineral composition given in table 1.

4 Gabbroic anorthosite (Whiteface facies); composite grab sample of ten specimens from exposures on a five-mile length along strike of border facies between Lake Flower and north of McCauley pond. Analyst, R. B. Ellestad.

5 Anorthosite (member of border Whiteface facies); first cut (about one mile) west of Saranac Lake station on New York Central and Hudson River railroad between Saranac Lake and Saranac Junction. Fine-grained equigranular rock speckled with red garnets. Analyst, A. Willman. Modal mineral composition given in table 2.

6 Norite, one and seven-tenths miles west of Gabriels. Analyst, R. W. Perlich. Modal mineral composition given in table 6.

7 Mafic metagabbro, two-thirds of a mile east of McCauley pond. Analyst A. Willman.

8 Ultramafic facies, on road three-fourths of a mile northwest of Shingle Bay. Analysts, B. Smith and R. B. Ellestad.

Whiteface facies. The Whiteface facies is developed only on a very limited scale in this quadrangle and is commonly not as clearly defined as in many other quadrangles in the Adirondacks. Rock similar to the Whiteface facies occurs within the Marcy facies as along the belt through Shingle Bay mountain and Loon bay but this is mapped with the Marcy facies.

Between the city of Saranac Lake and Saranac Junction the Whiteface facies is developed as a narrow border zone to the Marcy facies. South of the skarn layer south of the city of Saranac Lake the anorthositic rocks may have a coarse Marcy appearance almost up to the contact, though more garnetiferous and slightly more mafic than for the normal Marcy facies of the core. Northwest toward Saranac Junction near the border of the anorthosite mass there are many granoblastic bands interbanded with more Marcy-appearing rocks and the whole are in general garnetiferous. Between Colby pond and Lake Flower the Whiteface facies contains shreds and inclusions of Grenville skarn, as also on Baker mountain.

Northeast of Baker mountain the border facies comprises medium-grained granoblastic bands, mafic facies and bands of typical coarse-porphyroclastic Marcy anorthosite-augen gneiss.

It is not uncommon to find a "block structure" present in the border facies Whiteface anorthositic rocks. This has the form of lense-shaped blocks of medium-grained white anorthosite usually from a half foot to several feet in diameter in a groundmass which is commonly more mafic and is a gabbroic anorthosite. It has the appearance of an intrusive breccia, or the result of clotting of an aggregate of crystals suspended in a magma.

The Whiteface facies differs from the Marcy in having in general a higher percentage of femic minerals (cf. table 3, columns 4 and 5), of potash and a higher ratio of soda to lime. The higher percentage of femic constituents is a primary variation, but the higher percentage of orthoclase and albite molecules and to a less extent of quartz, is believed to be due, at least in part, to a secondary impregnation, and introduced by solutions derived from the younger intrusive syenitic magmas, now represented by the adjacent syenites. The mineralogical variation of some members of the Whiteface facies is given in table 2, number 2-6 inclusive. Previous study (Buddington, 1939, p. 31) has shown that in specimens from 13 localities in the border facies the feldspars in the uniform coarse-grained rock and in the augen porphyroclasts the andesine varies between An_{40} and An_{50} with an average of An_{45}. The groundmass of the augen gneiss, which in all but two specimens formed almost the whole rock, varied between An_{35} and

An_{44} and averaged An_{40}. The groundmass in all but one specimen was less calcic than the augen. As in the Marcy anorthosite augite and hypersthene are present in varying ratios to each other. Hornblende is found more often and garnet is of frequent occurrence. Apatite in general shows a higher percentage than in the Marcy facies.

Noritic and gabbroic rocks, anorthositic series. Noritic and gabbroic rocks form local masses and facies of the anorthosite massif, especially in the border.

Such rocks (table 2, numbers 6-8) are exposed in the hill two miles southwest of Gabriels, in the vicinity of the road for a mile west from a point about a mile west of Gabriels and in the hill just east of Osgood pond. They vary from norite and gabbro-norite to anorthositic gabbro-norite. Blocks of white anorthosite up to several feet in diameter are common as inclusions in the darker mafic facies and the gabbro-norite facies appears to have sharp contacts where seen locally against the anorthosite. The rock varies in texture from a very coarse foliated mortar gneiss with feldspars averaging an inch in length such as that at the old road metal quarry west of Gabriels to augen gneiss with only a small percentage of porphyroclasts. Augen gneisses are the most abundant and the porphyroclasts are commonly an inch or two in length, though locally varying up to eight inches.

The noritic and gabbroic rocks (table 2, number 9-12) also form conformable layers interbanded with more mafic facies in the hills northeast of McCauley pond and along the road a mile northwest of Shingle bay.

Many of the noritic and gabbroic rocks are characterized by an abnormally high percentage of apatite and combined ilmenite and magnetite. The younger Adirondack metagabbros average less than 1 per cent apatite whereas the metagabbros related to the anorthositic series carry up to 5 per cent apatite.

The gabbroic and noritic rocks are almost uniformly strongly metamorphosed and reconstituted so that garnet is commonly a major mineral.

Ultramafic rocks and mafic facies of gabbroic and noritic rocks, anorthositic series. Mafic facies of the gabbroic and noritic rocks occur as layers interlayered with gabbro or norite and conformable with the foliation of the anorthosite in the hills northeast of McCauley pond and along the road a mile northwest of Shingle bay. They also occur locally forming an intrusive groundmass inclosing lenses of anorthosite (table 2, numbers 13 and 14). Intrusive mafic gabbro rich in ilmenite magnetite and inclosing blocks of anorthosite also occurs on Baker mountain.

The mafic metagabbro (table 2, number 17), and mafic metanorite (table 2, number 15) of the band northeast of McCauley pond is interlayered with gabbro, gabbro-norite, and norite in layers usually a few inches but locally up to a few feet in thickness. The contact of the mafic rocks with the anorthosite was seen at only one place where it is conformable but sharp. One lense consists of a rock rich in olivine. This is the only olivine bearing rock (table 2, number 17) found in this area which is apparently related to the anorthositic series. The olivine is probably an iron-rich variety.

Several new road cuts for a length of about a half a mile and three and one-fourth to three and three-fourths miles west of Saranac lake show exposures of interbanded gabbro (table 2, numbers 11 and 12), mafic metagabbro (table 2, number 16) and ultramafic (table 2, number 19). At the west end the mafic layers are conformably interlayed with anorthosite instead of with gabbro and may represent the manner in which such layers finger out. They are several inches thick and one to two feet apart. All the rocks have a well-developed foliation.

All the rocks of both belts of layered mafic rocks are exceptionally rich in combined ilmenite and magnetite but it is noteworthy that whereas all members of the McCauley Pond band (table 2, numbers 9, 10, 15 and 17) are also exceptionally rich in apatite the rocks of the belt northwest of Shingle bay (table 2, numbers 11, 12, 16, 19) are all low in apatite. Similarly the mafic rocks inclosing blocks of anorthosite may be either exceptionally rich or quite low in apatite.

The layer of ilmenite-magnetite (table 2, number 20) is about three feet thick and is in a well-foliated medium-grained anorthositic gabbro-norite (table 2, number 5). The exposure is poor but the ilmenite magnetite appears to be conformable with the foliation.

Most of the rocks have been strongly metamorphosed and reconstituted so that garnet is a major mineral.

METAGABBRO, GABBRO GNEISS AND AMPHIBOLITE

Dark colored amphibolite and gabbroic gneiss form the bulk of the exposed outcrops in the area between Vermontville station (now abandoned) and Gabriels. The rocks are interpreted as parts of complexly folded olivine diabase sheets metamorphosed and intruded by granite with perhaps some Grenville para-amphibolite.

The rock varies from a metagabbro facies with diabasic texture, with at least part of each of the primary minerals, through a strongly deformed, intensely foliated, wholly reconstituted gabbro gneiss facies in which the major minerals are all new, to an amphibolite gneiss with some quartz and potash feldspar introduced by granitic solutions. The least deformed facies is found in general at the cores of the larger masses whereas the borders are commonly well-foliated amphibolite, especially where adjoining granite. The designation of much of the primary rock as probably olivine diabase is based on a study of many specimens of amphibolite and metagabbro throughout the Adirondacks (Buddington 1939, p. 61-63). The chemical composition of rocks with diabasic texture and of related amphibolites not modified by solutions given off by the syenitic and granitic magmas has quite uniformly been found to be equivalent to olivine diabase.

The least deformed facies, a metagabbro, was found on the hill one and one-eighth miles west-northwest of Bloomingdale railroad station (now abandoned). In the field the rock shows no foliation except in local shear zones. Examination with the microscope shows the rock to be over half recrystallized to a granular aggregate and over half reconstituted. Relics of primary texture show it to be subophitic with single augites filling the spaces between a meshwork of labradorite laths. Locally some primary hypersthene is associated with the augite. The primary labradorite and pyroxenes are cloudy with minute inclusions. The granoblastic aggregates of these minerals are clear. Similarly the borders of most primary individual labradorite and pyroxene grains are clear as a product of modification where they have entered into reaction relationships to form corona minerals. Corona structures are abundant. The most complex consist of a core of granoblastic brown hornblende with a grain of magnetite at the center or with grains of magnetite and a trifle green spinel disseminated in the central core. The hornblende is rimmed by hypersthene rods in radial arrangement, in turn partly or completely surrounded by garnet. The feldspar where it is against garnet is always clear and fresh appearing. The hypersthene shell may be absent and the hornblende adjoin the garnet shell directly. The primary labradorite is in part replaced by garnet. The mafic minerals thus consist of primary augite and hypersthene, and secondary augite, hypersthene, brown hornblende, garnet, magnetite and green spinel.

Greater intensity of deformation, reconstitution and recrystallization leads to the development of a garnetiferous gabbro gneiss or amphibolite in which the garnets and other minerals which form the corona structures in the metagabbro occur here as separate individual grains. Such garnetiferous facies were noted about one and one-quarter miles northeast of Gabriels, the hill two miles north-northwest of Vermontville station where at the northwest end disseminated garnet crystals average one-half inch to an inch, and the little hillocks in the swamp a mile southwest of Bloomingdale station. A specimen from one of the outcrops at the latter locality consists of a granoblastic aggregate of andesine, augite, hypersthene, brownish green hornblende, magnetite and ilmenite, a little perthitic orthoclase and occasional disseminated garnets up to one-half of an inch in diameter. The potash feldspar was probably introduced by solutions related to the granite and the composition of the rock is certainly somewhat modified from the original.

An intensely foliated wholly granoblastic facies from the south end of the hill north of Jones pond consists of the following minerals in per cents, labradorite 47, augite 27, hypersthene 16, biotite 7, microcline 1.5, magnetite 0.5, garnet 0.7 and accessory apatite 0.3. This facies has probably also been a trifle modified by passing solutions from the intrusive granitic magma but is in effect a gabbro gneiss.

A typical amphibolite may be seen in the small road metal quarry in the southwest end of the hill about one and three-eighths miles west northwest of Bloomingdale station. This amphibolite is the border facies of the metagabbro first described and is seamed with granite pegmatite veinings one-half to two inches wide. The dark rock consists of a granoblastic aggregate of andesine, green hornblende, augite, hypersthene and a little quartz, magnetite and orthoclase with accessory apatite. The andesine in part has antiperthitic intergrowths of orthoclase. The granite pegmatite seams in part show little or no deformation. This amphibolite represents considerable modification in composition of the original rock as well as reconstitution and recrystallization.

QUARTZ SYENITIC COMPLEXES

There are two series or complexes of quartz syenitic rocks each of which varies widely in composition. The variants of each series, however, have a common texture which serves to distinguish the facies of one series from those of the other and the variants of each series are furthermore spatially and structurally re'ated in a common unit so that each series is thought to have had a community of origin, and each constitutes perhaps a separate differentiated intrusive sheet.

On the Saranac quadrangle the quartz-syenitic rocks all have the feature in common of being green on fresh surface and weathering to a dark maple sugar color just beneath the gray surface veneer and of having a similar range of variation in composition. Characteristic variations in mineralogical and chemical composition are shown in tables 4-6. The rocks vary from mafic syenite (greater than 25 per cent mafic or dark minerals including pyroxene, hornblende, magnetite, ilmenite, apatite, garnet and sphene, through normal syenite (less than 10 per cent modal quartz and 0—20 per cent mafics), to quartz syenite (10—20 per cent quartz) and granite (greater than 20 per cent quartz).

All the rock types of each quartz syenitic series have the same texture but the texture is different for the two different groups. One series, the Saranac, has a medium-grained texture, the other, the Loon Lake series, has a texture varying from a coarse mortar gneiss to a sparsely coarsely porphyroclastic augen gneiss. Coarsely phacoidal structure is common and is diagnostic of the rocks of this latter series.

SARANAC QUARTZ SYENITIC COMPLEX

Mafic syenite. A belt of mafic syenite forms a belt bordering the main anorthosite mass. It weathers gray but is dark green on fresh surface. Wherever good exposures are present so that details can be seen, it is uniformly the case that the syenite has abundant lenses or schlieren, slightly different in grain (often finer grained), color or composition from the inclosing rock but nevertheless very similar to it. These schlieren are interpreted as portions of the Grenville limestones changed to skarn by solutions from the syenitic magmas and then intruded, torn to pieces and further modified by them. They are well-shown in the quarry at Moody pond. Xenocrysts of labradorite derived from the anorthosite may also be present, and locally there are small fragments of anorthosite included in the syenite.

Medium-grained quartz syenite. A medium-grained gneissic quartz syenite constitutes the major member of the syenitic series on the Saranac Lake quadrangle and underlies most of the central part of the area.

The rock has a dark green color on fresh surface and is medium-grained equigranular. A common feature of the rock consists of short narrow pegmatitic seams which extend out like splashes from a knot of pegmatite and while predominantly more or less parallel to the foliation yet may cut it at slight to moderate angles. The pegmatitic seams are in general massive and undeformed in contrast to the country rock. Locally they are garnetiferous. The abundance of these seams varies from place to place. The pegmatitic material is slightly richer in quartz than the normal quartz-syenite. The normal quartz-syenite has in general from 14 to 20 per cent quartz and a similar percentage

TABLE 4

Mineralogical Composition of Quartz Syenite and Mafic Syenite, Saranac Series

	MICROPERTHITE AND K FELDSPAR	PLAGIOCLASE	QUARTZ	HYPERSTHENE	AUGITE	HORNBLENDE	ILMENITE AND MAGNETITE	APATITE	ZIRCON	GARNET	SPHENE	PYRITE	CHLORITE AND BIOTITE	MAFICS
947..........	58.1	8.6	21.0	1.9	2.5	5.4	1.3	0.7	0.3	0.2	.....	.....	.....	12.0
949..........	53.5	13.5	20.2	3.9	2.4	2.7	2.0	1.0	0.5	0.3	.....	.....	.....	12.3
5917..........	51.1	17.5	14.3	2.6	6.7	4.7	1.3	0.8	0.5	0.3	0.2	.....	.....	16.6
713..........	44.7	19.8	18.2	5.6	3.5	5.0	1.5	0.9	0.5	0.3	.....	.....	.....	16.8
707..........	45.8	22.7	15.0	4.1	3.6	5.9	1.3	0.7	1.0	.....	.....	.....	.....	15.6
715..........	47.5	15.9	21.5	1.7	2.4	8.1	1.9	0.5	0.5	.....	.....	.....	.....	14.6
732..........	42.4	22.5	15.2	5.6	2.9	8.3	1.3	0.9	0.4	0.5	.....	.....	.....	19.5
5675..........	51.5	22.4	14.1	6.2	3.4	0.2	1.5	0.3	0.2	0.2	.....	.....	.....	11.8
899..........	53.3	22.5	10.0	.....	5.5	5.8	2.4	0.2	0.3	.....	.....	.....	.....	13.9
5687..........	43.8	18.3	16.9	5.7	3.6	9.8	1.1	0.5	0.3	.....	.....	.....	.....	20.7
887..........	38.2	24.9	11.1	6.4	7.9	6.2	3.6	1.3	0.4	.....	.....	.....	.....	25.4
932..........	51.7	16.1	12.6	4.4	5.5	5.5	2.2	0.9	0.5	0.6	.....	.....	.....	19.1
775-a.......	45.1	28.2	9.9	2.0	6.5	3.7	3.9	0.5	0.2	.....	.....	.....	.....	16.3
935..........	45.7	27.4	7.3	2.7	8.4	2.6	2.0	1.0	0.6	2.3	.....	.....	.....	19.0

926.........	37.6	32.8	3.7	11.3	11.3	.....	1.9	1.2	0.2	.....	.....	.....	.....	25.7
5682.........	36.9	29.5	8.0	2.2	13.3	0.4	2.2	0.9	0.3	6.3	.....	.....	.....	25.3
994.........	47.2	25.4	2.1	2.4	12.4	2.2	3.0	0.7	0.4	4.2	.....	.....	.....	24.6
928.........	47.0	25.2	1.7	5.2	10.4	.....	3.4	0.5	0.6	6.0	.....	.....	.....	25.5
772.........	37.1	30.8	1.2	7.3	12.7	3.6	3.0	1.1	0.3	2.9	.....	.....	.....	30.6
5657.........	39.2	22.7*	3.4	2.8	12.6	0.4	8.2	2.1	0.4	8.0	.....	0.2	.....	34.3
5795-E.......	23.5+	35	3.0	11.2	16.0	3.0	5.6	2.1	0.4	0.2	.....	.....	.....	38.1
5680.........	36.2	24.1	0.3	9.2	14.1	.....	9.2	2.9	0.2	3.6	.....	0.2	.....	39.2
709.........	29.4●	28.1	3.0	13.6	9.8	3.6	5.5	1.4	0.8	4.8	.....	.....	.....	38.7
811.........	42.8	20.6	4.3	4.3	9.0	1.2	9.1	1.0	0.5	7.2	.....	.....	.....	31.8
790-a.......	25.8	37.2	3.1	9.8	12.7	2.0	6.3	1.8	.....	1.1	.....	.....	.....	33.9
924.........	37.7	31.5	0.3	8.0	11.3	.....	5.6	1.3	.....	4.3	.....	.....	.....	30.5

* 2/3 myrmekite
\+ microcline
● about 1/3 rd microperthite

Table 5

Chemical Analyses and Norms of Members of Syenitic Series

	SARANAC					LOON LAKE		
	1	2	3	4	5	6	7	8
SiO_2	48.32	53.35	60.51	67.48	69.87	61.47	63.45	70.15
Al_2O_3	10.02	14.97	14.16	13.12	14.58	15.70	18.38	15.19
Fe_2O_3	7.25	3.31	1.60	1.43	.56	1.18	1.09	.61
FeO	14.57	10.61	8.02	5.06	1.80	5.95	2.69	1.58
MgO	2.54	1.72	1.17	.55	.57	1.15	.35	.30
CaO	7.22	6.43	4.14	2.45	1.69	3.99	3.06	1.58
Na_2O	1.97	3.50	3.47	3.16	2.52	4.10	5.06	3.71
K_2O	2.48	3.74	4.38	5.06	7.42	4.47	5.15	6.15
H_2O^+	.32	.14	.10	.31	.11	.16	.30	.05
H_2O^-	.07	.10	.09	.07	.09	.09		.06
CO_2	.14	....	....	....	....	....	....	....
TiO_2	3.44	1.38	1.52	.96	.24	1.24	.07	.30
P_2O_5	1.36	.71	.58	.27	.09	.40	....	.07
S	.14	....	....	....	....	....	....	....
MnO	....	....	.17	.12	.04	.13	....	.04
	99.84	99.96	99.91	100.04	99.58	100.03	99.73*	99.79

* Also contains 0.13 per cent BaO.

NORMS

Quartz	8.28	0.48	11.07	22.2	21.93	9.03	5.06	20.49
Orthoclase	15.01	21.68	26.13	29.7	43.92	26.69	31.14	36.42
Albite	16.77	29.34	28.82	26.7	20.96	34.58	42.44	31.44
Anorthite	10.84	14.46	10.15	6.5	6.67	11.12	11.68	6.53
Diopside	13.71	11.21	6.12	4.3	.93	5.23	2.15	.94
Hypersthene	14.34	13.80	10.96	6.3	3.44	8.01	6.11	2.32
Magnetite	10.56	4.87	2.32	2.1	.81	1.74	.70	.93
Ilmenite	6.60	2.74	2.89	1.8	.46	2.36	....	.58
Apatite	3.22	1.68	1.34	0.6	.20	1.00	....	.17
Calcite	.30	....	....	....	....	....	....	....
Femics	48.43	34.30	23.63	15.1	5.84	18.34	8.96	4.94
	$Ab_{61} An_{39}$	$Ab_{68} An_{32}$	$Ab_{75} An_{25}$	$Ab_{81} An_{19}$	$Ab_{77} An_{23}$	$Ab_{77} An_{23}$	$Ab_{80} An_{20}$	$Ab_{83.5} An_{16.5}$

1 Mafic syenite (Shonkinite), quarry northeast of Moody pond, (Balk, 1931, p. 425). An exceptionally mafic band for this quarry. Analyst, R. B. Ellestad.

2 Mafic syenite quarry northeast of Moody pond. Analyst, A. H. Phillips. (From Buddington, 1939, p. 425).

3 Syenite, quarry one mile northeast of Vermontville. The rock is seamed with pegmatitic facies. Analysts, G. Kahan and R. B. Ellestad.

4 Quartz syenite, on road three-quarters of a mile north of Peck's Corners. Analysts, B. Smith and R. B. Ellestad.

5 Quartz-syenite pegmatite from 3-inch vein across foliation of quartz syenite, quarry just south of Balfour lake, Newcomb quadrangle. The rock is massive and coarse except for a trifle recrystallized mortar. It consists of microperthite, oligoclase, hornblende and quartz with accessory apatite, magnetite and zircon. There is a trifle garnet replacing feldspar and occasional garnet coronas around the magnetite. Analysts, G. Kahan and R. B. Ellestad.

6 Syenite, four miles northeast of Vermontville, one-quarter of a mile south of north border of quadrangle. Analysts, G. Kahan and R. B. Ellestad.

7 Syenite, railroad cut at west end of Loon lake, Loon Lake quadrangle. Analyst, E. W. Morley. Described by Cushing 1907, p. 514.

8 Quartz syenite (Hawkeye granite), four-fifths of a mile east of Oregon pond at Onchiota. Analysts, G. Kahan and R. B. Ellestad.

TABLE 6

Minerological Composition

Loon Lake Complex

	MICROPERTHITE AND K FELDSPAR	PLAGIOCLASE	QUARTZ	HYPERSTHENE	AUGITE	HORNBLENDE	ILMENITE AND MAGNETITE	APATITE	ZIRCON	GARNET	SPHENE	PYRITE	CHLORITE AND BIOTITE	MAFICS
796.........	60.1	15.8	21.3	0.9	1.0	0.1	0.6	0.1	0.1	.....	.....	.....	.....	2.7
848.........	53.2	21.6	18.8	1.1	1.7	0.6	2.4	0.3	0.2	.....	.....	0.1	.....	6.2
787.........	42.2	28.3	11.1	6.0	6.0	1.6	3.2	1.0	0.2	.....	.....	.....	.....	17.8
799.........	38.3	36.2	1.2	7.7	7.6	1.8	3.9	0.8	0.5	2.0	.....	.....	.....	23.8

of mafic minerals. The latter comprise augite, hypersthene, hornblende, magnetite, ilmenite, garnet and apatite.

A chemical analysis of a representative massive cross cutting pegmatite vein is given in table 5, column 5. This specimen came from a different area and may not be typical of similar veins found in the quartz-syenite of the Saranac complex. It is more quartzose than the normal quartz-syenite and has a conspicuously higher ratio of orthoclase to albite than any quartz-syenite of the Adirondacks so far studied. A small massive crosscutting pegmatite vein in the quarry north of Bloomingdale shows hornblende and no pyroxene and has a concentration of euhedral zircons and apatite above what is present in the normal quartz-syenite.

LOON LAKE QUARTZ-SYENITIC COMPLEX

Phacoidal syenite. Syenite gneiss with a coarse lenticular or phacoidal structure forms the south end of the core of an anticlinal dome in the extreme northeastern corner of the quadrangle. The phacoids vary from one-half to one and one-half inches in length. Most are composed wholly of granoblastic feldspar crushed and recrystallized from original large perthitic feldspars. A few contain relic porphyroclasts of feldspar. These weather in relief and give to the surface a rough small-scale jagged appearance.

Phacoidal quartz-syenite and granite. A rock varying in composition from a quartz-syenite gneiss to granite gneiss and having a coarse phacoidal or lenticular structure forms a belt around the phacoidal syenite in the northeastern part of the quadrangle. This rock has a more extensive development to the east on the Lake Placid quadrangle where it was mapped as granite porphyry by Miller and to the northeast on the Lyon Mountain quadrangle where Miller mapped it as the Hawkeye granite. Like the phacoidal syenite the phacoids vary from one-half to one and one-half inches in length and are composed largely of granoblastic aggregates of feldspar with a few carrying porphyroclastic relics of the original large feldspars. Very locally the porphyroclasts are so large and abundant as to form an augen gneiss and very rarely a mortar gneiss. The quartz weathers out conspicuously on the surface as leaves wrapping around the phacoids of feldspar. The rock is green on fresh surface but pinkish to gray on the weathered surface.

GRANITE

Red granite forms part of the hills southwest of Harrietstown, much of the hills west of Vermontville station and the hill north of Clear pond. It is a typical hornblende-granite gneiss. The intensity of development of the foliation is variable. The rock consists of oligoclase, microcline, perthite, orthoclase, quartz, several per cent of green hornblende and accessory magnetite, apatite and zircon. The feldspar forms aggregates of polygonal grains and the quartz varies in shape from massive leaves to only slightly elongate amoeboid-shaped grains. The percentage of hornblende varies in amount. There are local included layers and shreds of amphibolite. Pegmatitic seams are commonly present and are locally garnetiferous.

Gray granite which is presumably a facies of the red granite forms the trough of the Bloomingdale syncline and much of the top of the ridge of hills southwest of Bloomingdale. The granite has a gneissic structure and contains thin layers and shreds of Grenville amphibolite and locally light-colored paragneisses. In part it is contaminated by homogeneous incorporation of Grenville rock. One inclusion of anorthosite was noted. The amount of mafic mineral in the gneiss varies considerably. Pegmatitic seams are common. In thin section the rock is found to be predominantly a hornblende-granite gneiss consisting of perthite, oligoclase, microcline, orthoclase, quartz, several per cent of green hornblende and accessory magnetite, apatite and zircon. The feldspar is in polygonal grains and the quartz in massive leaves. The hornblende is in form of elongate flat lenses parallel to the plane of foliation. Locally biotite is the dark mineral in place of hornblende.

DIABASE

Only a few diabase dikes are present in the Saranac quadrangle though they do occur here and there throughout the area. This is consistent with the fact that they are in general more numerous in the eastern and northern borders of the Adirondacks. Only 15 were seen in the course of work in this area whereas Miller (1919, p. 60) noted 61 in the Lake Placid area to the east, and over 120 in the Lyon Mountain quadrangle to the northeast (Miller, 1926, p. 60). The dikes are rarely over two or three feet wide and can not be traced for more than several hundred feet in length.

The texture of the diabase ranges from medium grain in the heart of the wider dikes to dense and glassy in very narrow dikes and in the chilled selvedges of the dikes. Microscopic examination shows the texture in general to be doleritic as distinguished from ophitic.

A dike on the St Regis quadrangle just at the south end of Mountain pond shows well the gradation in texture from wall to center. The rock of the wall is dense and stony with a conchoidal fracture. The core is medium grained. In thin section the wall rock is seen to consist of crisscrossing plagioclase microlites with interstitial areas which are effectively opaque except at the highest magnification when they are found to be composed of a birefracting aggregate with a lattice work or screen of iron oxide filaments. There are a few microphenocrysts which now consist of carbonate and a little serpentine but were probably originally olivine. This type of rock grades quickly into one in which the birefracting material is clearly identified as pyroxene and the rock has a doleritic texture. The rock of the core has a doleritic texture and consists of crisscross labradorite laths and subdiomorphic pyroxene grains with subordinate iron oxides and a few idiomorphic olivine grains. There are also aggregates of carbonate or of carbonate and a little serpentine pseudomorphous after olivine. Locally there is a trifle biotite around the iron oxides. The latter are present predominantly as grains but in part as skeletal crystals. The pyroxene is wholly augite.

Specimens from four dikes were studied with the microscope. All were olivine diabase like the dike just described. Dikes without olivine or with a little enstatite or with considerable biotite have been described from adjoining quadrangles and further study would probably have found them on the Saranac quadrangle.

STRUCTURE AND ORIGIN OF THE ROCK COMPLEXES

INTRODUCTION

Major structural elements are the Newman syncline which occupies the southeast corner of the Saranac quadrangle, the southwest corner of the adjoining Lake Placid area, and overlaps on the northeast and northwest corners respectively of the Santanoni and Mount Marcy quadrangles; the St Armand anorthosite prong running northeast through McKenzie and St Armand mountains from Ray Brook; a portion of the main Adirondack anorthosite massif which underlies the southwest corner and west border of the quadrangle; the Saranac synclinorium embracing the belt between the St Armand anorthosite prong on the southeast and the main anorthosite massif on the south and west and the Katy Mountain unit. The Saranac synclinorium is a composite complex structure composed of at least two parts, a relatively simple syncline which will be here called the Bloomingdale syncline and the unit of complex structure to the northwest named the Rainbow structure.

NEWMAN SYNCLINE

Only a part of the Newman syncline is exposed in the southeast corner of the Saranac quadrangle. The major portion lies on the adjacent Lake Placid, Mount Marcy and Santanoni quadrangles and the village of Newman (Lake Placid quadrangle) is about in its center. The syncline is clearly-defined for a width of about five miles and a length of about ten. At the southwest end it is bordered by anorthosite of the main massif. The anorthosite is overlain by mafic syenite which passes gradationally upwards into quartz syenite and is overlain by a series of Grenville beds with some associated intrusive reddish granite which occupies the trough of the syncline. Locally there are intrusive lenses of Whiteface gabbroic-anorthosite between the Grenville and the quartz-syenite as in the hill five-eighths of a mile south of the southeast corner of the Saranac quadrangle on the Santanoni area, and one-half mile west of Malcom pond on the Lake Placid sheet. The Grenville series comprises crystalline limestones, para-amphibolite and minor quartzite. The northwest limb of the syncline for several miles southwest of Whiteface is wholly obscured by glacial drift. There is a marked discordance between the foliation in the anorthosite north of this belt of drift and that of the syenitic rocks of Scarface mountain and it seems probable that this is due to a fault.

ANORTHOSITIC COMPLEX: FORM AND ORIGIN

St Armand anorthosite prong. A great prong of anorthosite several miles wide extends northeast from Ames Mills and forms the high ridge of McKenzie and Moose mountains. It terminates in a blunt border on the Lake Placid sheet just to the east of the border of the Saranac quadrangle. It lies between the Saranac and Newman synclines and an anticlinal structure might therefore be sought in it. The Saranac-Placid trail runs from Whiteface by way of the south side of McKenzie pond to Saranac lake. North of this trail the anorthosite shows an anticlinal or domical foliation. The rocks on the entire ridge top from a mile west southwest of McKenzie mountain to Moose mountain have consistently a quite gentle dip whereas on the southeast slope the foliation dips increasingly steeply east down the mountains towards Lake Placid. An anticlinal nose pitching northeast is also indicated by the foliation north and northwest of Moose mountain.

There is an increase in the degree of granulation of the anorthosite in the rocks of the ridge top at the crown of the dome. Gabbroic garnetiferous anorthosite facies also occur as bands at the higher altitudes. Both these features are characteristic of the "Border Facies" of the anorthosite and together with the structure suggest that the rocks of the McKenzie-Moose mountain ridge top must have originally been not far below the actual roof of the anorthosite arch.

Between the Saranac-Placid trail on the north and the railroad on the south the anorthosite is almost uniformly a normal Marcy facies with a granulated groundmass constituting not more than half the rock and has a consistent structure which strikes about N.10 E. and dips nearly vertical to steep east. The foliation is distinct on horizontal surfaces and locally in bands on vertical joint faces but, in general, vertical faces about at right angles to the strike of the foliation show a haphazard arrangement of the augen and phenocrysts or a highly confused structure. The granulation has been superimposed on a primary flow structure for some bands with less than one-fourth groundmass show all the feldspars parallel oriented. No anticlinal structure can be distinguished in this part of the prong. The rocks of this part of the mass are consistently less granulated, coarser textured, or have less mafic facies, and are lower in altitude than that to the north. These features suggest that this part of the prong is a deeper seated facies.

The observed data are not sufficiently definitive to positively decide whether the prong is a simple dome-shaped unit pitching northeast with the core having an indistinct vertical foliation overlain by a flat roof or whether the structure is complicated by faulting. The failure to find adequate evidence of gradation in dip between the southern block with steeply dipping foliation and the northeastern with gentle dips has led the writer to the hypothesis that the two blocks are separated by a fault running a little north of west from Whiteface. The block with steep foliation would then have the relation of a horst to the Newman syncline and the McKenzie mountain block of gentle foliation.

Main anorthosite massif. In general the portion of the main massif exposed on the quadrangle shows a foliation dipping outwards gently to moderately parallel to its borders. It thus constitutes the northeast part of a great dome.

There are, however, local discordances in the structure for which the writer has been unable to give a satisfactory interpretation due to paucity of good outcrops. Southwest of Loon bay and along Boot bay on Lower Saranac lake there is a belt of rock which strikes north northeast and dips gently east in a locality where a more westerly strike would seem normal. The rock also is predominantly a strongly-foliated even-grained granoblastic gabbroic anorthosite with a few disseminated phenoclasts whereas the bordering rocks are typical coarse Marcy type with indistinct foliation or such a massive structure that foliation cannot be determined. There are several smaller scale local discordances and in each case the discordant rocks are more strongly foliated suggesting that they are shear zones formed during the period of general deformation and plastic flowage of the anorthositic rocks. Southwest of Loon Bay, however, there is a band of mafic gabbro parallel to the foliation of the anorthositic rocks indicating that if the discordant belt is a shear zone it must be related to accentuation of a primary structure on very sharp bends or between slips or the structure is contemporary with the consolidation of the magma.

Origin of anorthosite and allied rocks. Two hypotheses have been put forward to explain the origin of the anorthosite. One hypothesis proposes that the anorthosite, gabbro, syenitic rocks and granite are a related group of rocks derived from a common magma; the anorthosite representing an accumulation or aggregation of solid crystals as a result of gravity sorting, flowage-clustering, or filter pressing; and the syenitic and granitic rocks representing the residual magma separated from the complementary solid crystal fraction by one or the other of the processes enumerated. This hypothesis presupposes that the anorthosite was not emplaced as a magma of approximately its own composition. The other hypothesis assumes that the anorthosite is the product of consolidation of a magma of approximately the bulk composition of the rocks described in this report as members of the anorthositic series. Since anorthosite is by far the predominant member of this series and the other members are mafic facies the bulk composition would be that of a gabbroic anorthosite. Primary magma of the composition of gabbroic anorthosite under this second hypothesis yielded by differentiation the more feldspathic anorthosite and the more mafic-gabbroic facies. The writer has elsewhere (Buddington, 1939, p. 201-21) discussed reasons for preferring the second hypothesis. In summary they are that border facies such as might be interpreted as the least differentiated primary magma has the composition of gabbroic anorthosite; there are isolated satellitic sills of the composition of gabbroic anorthosite in the Grenville series as in the hill three-fourths of a mile south southwest of the northeast corner of the Santanoni quadrangle, a garnet-rich type of replacement is characteristic of the contact zone between the anorthositic intrusions and limestone and is almost if not wholly restricted to such zones, alkali feldspars are absent from contact zones of limestone with the anorthositic series and by contrast are usually common in contact zones between limestone and syenitic or granitic rocks, and finally the Whiteface gabbroic anorthosite locally contains angular inclusions of skarn, and layers, schlieren, shreds and disintegrated relics of skarn as though a gabbroic anorthosite *magma* intruded and incorporated the skarn.

The local gabbro, gabbro-norite, and norite, the mafic facies of these, and the trifling amount of ultramafic rock, all have intrusive relationships to the Whiteface and Marcy facies and are interpreted as the product of residual magmas from the crystallization of the great body of anorthosite. The high concentration of ilmenite and magnetite and especially of apatite in much of the exceptionally mafic and ultramafic rock suggests that they may be allied to an epimagmatic or pegmatitic mode of origin.

The gabbro-anorthositic magma is thought to have come into the Grenville rocks so as to yield several domical shaped laccolithic-like upper surfaces with intervening sags such as that represented by the Saranac synclinorium between the main domical anorthosite massif and the St Armand domical prong. The thickness of the main anorthositic mass and its shape in depth is entirely a matter for speculation as there is no direct evidence.

BLOOMINGDALE SYNCLINE AND STRUCTURE AND ORIGIN OF SARANAC SYENITIC COMPLEX

Bloomingdale syncline. The Bloomingdale syncline lies between the St Armand anorthosite prong and the granite and metagabbro masses west of the old Delaware and Hudson Railroad line. It extends from the southern edge of the city of Saranac Lake northeast through Bloomingdale and Vermontville to the Katy mountain structure. It is about 11 miles long and three and a half miles wide. The outer layer of the syncline except on the west is composed of mafic syenite which overlies the anorthosite or contains blocks and inclusions of anorthositic rocks. This grades upward through a narrow layer of syenite into quartz-syenite. Overlying the quartz-syenite are beds of the Grenville series with locally some complex minor folds, and the trough of the structure is occupied by gray granite gneiss with thin layers and shreds of amphibolite. Despite the fact that the syenitic and granitic rocks are intrusive there is essentially complete conformity between them and the Grenville beds.

Origin of Saranac syenitic complex. The syenitic rocks were interpreted by the earlier workers as batholithic intrusives. Data accumulated in recent years, however, (Buddington, 1939, p. 116-23, 232-34) seems to indicate that they may be described as deformed sheets. The Saranac syenitic series definitely has the relationships of a conformable synclinal structure underlying the Grenville of the Bloomingdale and Newman synclines. Two rather sharply contrasted rocks form almost the entire bulk of the Saranac sheet, a mafic syenite with less than 5 per cent quartz and 25 per cent or more of mafics and a quartz syenite with more than 12 per cent quartz, and less than 20 per cent of mafics. There are intermediate transitional types but quantitatively they form but a small per cent of the total volume. The mafic syenite uniformly overlies the anorthosite and underlies the quartz-syenite within both synclines. Dikes of mafic syenite are found in the underlying anorthosite. No intrusive relationships between the mafic syenite and the quartz-syenite were found, though as indicated there must be a relatively sharp gradation. The ratio of the thickness of the quartz-syenite to the mafic syenite layer is highly variable as is brought out by the areal distribution. The quartz-syenite is thin at the south end of the Bloomingdale syncline and quite thick at the north end.

The mafic syenite has been traced almost continuously around the anorthosite massif from the northeast corner of the Santanoni quadrangle northwest across the Saranac quadrangle, west across to the St Regis area and southeast across the southeast part of the St Regis quadrangle to the central part of the Long Lake quadrangle, a distance of over 60 miles. In all cases where examination has been made the mafic syenite is found to be overlain conformably by quartz-syenite.

This stratiform arrangement is thus one in which the rock at the top is more salic and lighter in specific gravity than the one below and the rock at the base is more mafic and heavier in specific gravity than that above with a narrow gradational layer between. This suggests the possibility that the arrangement is due to fractional crystallization and gravity sorting of minerals, with the earlier and heavier crystallized portions sinking in the magma to be concentrated in the lower part and the residuum and lighter minerals rising to the upper part. The writer believes this is a major factor. There are, however, complications.

The mafic lower portion also has abundant schlieren of mafic skarn. This suggests the hypothesis that the mafic character of the syenite is due to a homogeneous distintegration and incorporation of skarn by a more felsic magma. The writer believes that this is indeed a factor. The quartz-syenite, however, also locally contains abundant schlieren of skarn or amphibolite origin but although by incorporation it may become more mafic it still remains a quartz-syenite, so that incorporation is probably not the only factor in the origin of the mafic lower-layer.

Again mafic syenite also occurs as discrete dikes in the anorthosite as two miles west of Gabriels and at the southwest end of Colby pond. Also the layered-gabbroic and mafic gabbroic rocks northeast of McCauley pond are at the southeast transgressed and cut out by the main body of mafic syenite. Small dikes of mafic syenite also crosscut the foliation at this locality. This raises the question as to whether the mafic syenite is the product of intrusion of a separate primary magma of about its present composition, and this in turn was followed by intrusion of a more salic magma which yielded the quartz syenite layer. Such a successive intrusion would be consistent with the occurrence of mafic syenite as dikes, and with the relatively small zone of transition rock between the mafic syenite and quartz-syenite respectively. It is, however, difficult to visualize the dynamics whereby a later more salic quartz-syenite-magma is brought in consistently above an earlier syenite sheet, without showing some obvious intrusive relations to it, especially where the sheet has such great extent and probably curved form. The same objection would apply if the order of intrusion were reversed and quartz-syenite preceded mafic syenite-magma. Dikes of quartz-syenite in the anorthosite were not found in the Saranac area though they are known elsewhere.

Another hypothesis is that the primary magma had a composition of quartz-syenite. At depth portions of this became mafic through incorporation and assimilation of skarn, amphibolite, and metagabbro. This heterogeneous magma after intrusion as a sheet differentiated under the influence of gravity so that lighter less-contaminated facies rose to the top and the mafic "incorporation facies" remained at, or gravitated to, the lower part, also becoming more mafic through additional incorporation of mafic materials included during intrusion. The differentiation was further accentuated by gravity acting in conjunction with fractional crystallization. Most of the dikes would then be mafic syenite because magma which had become quite mafic through incorporation would be the earliest to consolidate and become set in the openings in the anorthosite. This is the hypothesis previously adopted (Buddington, 1939, p. 121).

The Saranac sheet does not show exclusively simple uniform major synclinal structures. There are local minor reversals of dip indicated within the major structure.

This is also true of the Grenville series. Structural relationships peculiar to the syenitic sheet, however, have also been noted. At the old quarry, northeast of Bloomingdale the dip of planar foliation is west on the west side of quarry and east on the east side and the change from one to the other is through the vertical. This is the only place where this was noted.

The Saranac complex has been found to be continuous with the Tupper complex and allied in structural relationships with the medium-grained syenite and quartz-syenite of the Santa Clara complex (Buddington, 1939, p. 111-23). It is also continuous with syenitic rocks that extend on to the Lake Placid quadrangle. If these rocks constitute a single deformed sheet then it has as now exposed a minimum length of 50 miles and a width of 30 miles.

Belt of intrusive igneous breccia. In the northeastern part of the quadrangle there is a band of mafic syenite with abundant inclusions of the anorthositic series varying in size from a few feet in diameter to a mile. The composition of the inclusions varies from gabbro and norite to Marcy anorthosite. The band is at least 11 miles long as it has been traced from south of the Saranac river, through Onchiota to Lake Kushaqua on the Loon Lake quadrangle. The structure of the band where it strikes northwest is conformable with that of the bordering rocks but where it strikes north south for about three miles at its southern end there is a profound discordance between the orientation of its own plane of foliation and that of the adjoining country rock. At the northwest, in Katy mountain, the foliation of the breccia strikes northwest and dips 30°—50° E, north and east of Vermontville it strikes northwest and dips 70°—80° W. These orientations are consistent with the inclosing country rock. On the Saranac river, however, the foliation strikes north and is in general steep to vertical whereas the strike of the country rock along the river is about east-west and moderate north. Similarly in the ridge about two miles north of the river the strike of the foliation of the breccia band is north-south and dip steep whereas that of the quartz-syenite on the east is east-west and gentle south. Again in the ridge south of the river the foliation of the breccia band is north-south with a gentle west dip whereas the country rock to west strikes about east-west and dips gentle north. The strike of the plane of foliation appears in general to be parallel to the trend of the band. These discordant relationships in the southern three miles of the belt might be due either to faulting or to primary transgressive relations normal to intrusion as a dike or to a combination of the two. No contacts were seen and only inferences can be drawn. No inclusions of older syenitic rocks or of Grenville were seen in the breccia mass though since no really good exposures were found it is possible that they are present but were not distinguished. The sharp change in the character of discordant relationships at the south end certainly seems to necessitate faulting as at least a major factor in their interpretation. It is uncertain whether the breccia is an intrusive dike or the base of the Saranac quartz-syenitic sheet.

STRUCTURE AND ORIGIN OF LOON LAKE SYENITE COMPLEX, KATY MOUNTAIN ANTICLINE

The rocks in the northeast corner of the quadrangle are involved in a structural unit which extends across on to the adjacent quadrangles. It has not yet been mapped on the Loon Lake area, is therefore only partially known and the present discussion must be tentative only and subject to modifications which may become necessary in the light of future knowledge of the whole structure. The rocks involved in the structure are the two members of the Loon Lake complex, namely, the coarse phacoidal syenite and the coarse phacoidal quartz-syenite, the band of mixed mafic syenite and anorthosite, and rare layers of Grenville included in the Loon Lake series.

On the basis of the structure of the Loon Lake series as mapped on the Saranac and Lake Placid quadrangles the structure as a whole is interpreted as the south end of an anticline overturned toward the southwest. The nature of the structure is best brought out by the quartz-syenite. On the east side of the Saranac quadrangle and to the northeast on the Lake Placid area the foliation of the quartz-syenite dips southeast. In the hills about three miles northeast of Vermontville the foliation dips steeply southwest and on the nose as in the hill two and one-half miles east northeast of Vermontville the strike is east-west and the dip gentle south thus outlining the pitching nose of a normal anticline. To the north and northwest of Vermontville, however, the foliation gradually steepens to vertical and then reverses its direction of dip so that in Katy mountain it is about 40° northeast. The data suggest an overturned anticline pitching about 25° to the south, with an axial plane dipping about 45°—50° to the east. As is usual in the case of the Adirondack rocks which have undergone plastic flowage as a consequence of strong deformtaion, the planar foliation is indistinct on the pitching nose of the fold whereas the linear structure is pronounced and exceptionally well-developed.

In the eastern part of the structure the linear element is parallel to the axis of this part of the fold and strikes north-south to N. 10 E. In Katy mountain and the western part of the structure the linear element strikes east-northeast to east. The linear structure in the Adirondacks is in part parallel to the axes of the folds as exemplified in the Bloomingdale syncline. The reason for the discordance between the strike of the axis of the Katy mountain fold and the linear structure is not obvious and must await further study. It may be noted, however, that the linear structure is about down-dip where the fold is overturned.

The lowest member of the rocks exposed on the anticline is the syenite of the belt extending through the eastern part of Katy mountain ridge. This syenite belt has been traced for a couple of miles to the northwest through Mud Lake mountain (Loon Lake quadrangle) and the hills to the east. Unfortunately the entire area where the rocks of the core of the anticline might be expected is wholly covered with delta sands both on the Saranac quadrangle and in the southeast corner of the Loon Lake area. The syenite grades upwards into quartz-syenite and no intrusive relationships between them were observed. The syenite and quartz-syenite of the Loon Lake series appear to be linked by structural continuity across the Loon Lake quadrangle to the Santa Clara syenitic series of the Jennings mountain (Santa Clara quadrangle) dome (Buddington, 1937, p. 42-45) where pyroxene syenite similarly lies below pyroxene quartz-syenite on the core of an anticline. The Loon Lake complex was interpreted by Cushing (1905, p. 402) as forming a batholith. Batholiths, however, where there is a variation in composition normally have the more felsic facies at the core and the more mafic facies at the border in contrast to the reverse relationship formed in the structure of the Loon Lake series. The pyroxene syenite has a higher specific gravity than the pyroxene quartz-syenite and structural data indicate it lies below it. The relationship of the rocks of the Loon Lake series are thus consistent with what would be expected if a differentiated stratiform sill or phacolithiclike sheet of igneous rock were strongly folded and subsequently exposed by erosion. The normal relationship of syenite overlain by quartz-syenite is shown in the two hills just south of the Sable Mountain ridge and in the Loon Lake Mountains on the Loon Lake quadrangle.

The phacoidal pyroxene syenites and quartz-syenites have been traced across the Lyon Mountain, Loon Lake, Santa Clara, Nicholville and Stark quadrangles on to the Russell quadrangle for a total length of about 70 miles. The rocks are not continuous throughout this length but structural relationships so far as known are consistent with the possibility of their belonging to a single mass. They are in a belt about ten to 15 miles wide. On the southwest the phacoidal syenitic series are separated from a similar series of rocks constituting the Diana complex by a great width of crosscutting batholithic younger granite. The Diana complex (Buddington, 1939, p. 73-109) has similarly been interpreted as a close folded, in part overturned gravity stratified sheet. In addition to pyroxene syenite and quartz-syenite like that of the Loon Lake or Santa Clara series it also shows more mafic syenitic facies and may give a clue as to what might be expected to be found if deeper portions of the folds and the lower layers of the Loon Lake and Santa Clara sheets could be found.

The quartz-syenite in certain areas bulks much larger than the syenitic facies and since it was the last facies to consolidate it may well have moved and been concentrated in some zones and diminished in volume in others as compared with the primary relationships.

INTERRELATIONSHIPS OF SARANAC AND LOON LAKE COMPLEXES

The Loon Lake syenitic complex on the Saranac quadrangle is adjoined, and if the structural interpretation is correct, is overlain on the southwest flank by the belt of mafic syenite with associated included anorthosite, and on the southeast flank on the Lake Placid quadrangle by an anorthosite sheet with associated Grenville. The relationship between the anorthosite sheet and the syenite-anorthosite breccia around the nose of the structure can not be determined due to faulting and drift-covered areas.

The roof rocks of the phacoidal quartz-syenite on the Santa Clara quadrangle are heterogenous medium-grained rocks varying from pyroxene quartz-syenite to mafic syenite, the latter predominating and often containing included bands and schlieren of amphibolite. These medium-grained syenitic rocks were formerly interpreted (Buddington, 1939, p. 111-16) as a relatively chilled or modified facies of the same magma which yielded the coarse phacoidal series and as essentially part of the same sheet and belonging to the same period of intrusion. Subsequent work, however, has shown that the medium-grained syenitic rocks interpreted as a facies of the Santa Clara complex in addition to being lithologically similar are structurally related to the Saranac syenitic series. Reasons have already been given for considering the Saranac series as constituting a differentiated stratiform sheet. The Saranac sheet forms a unit in itself, and the hypothesis that it represents an intruded mass of an epoch separate and distinct from that which gave rise to the Loon Lake series deserves consideration. The writer has nowhere seen exposures which were adequate to warrant the conclusion that there is no gradation between rock of the Saranac and that of the Loon Lake type. The impression one gets, however, is that if there is a gradation it must be sharp. On the hill two miles north northwest of Vermontville a phacoidal quartz-syenite band was found within the mafic syenite of the Saranac series though no actual contacts were found. The fact that the Saranac series appear to constitute a strongly *differentiated* sheet is the strongest reason for considering it a separate unit.

When we consider it as a separate complex, however, some difficulties arise. The Saranac sheet as it plunges down off the anorthosite massif everywhere consists of mafic syenite below and quartz-syenite above but where it rises on the Jennings mountain dome (Santa Clara quadrangle) it consists of pyroxene quartz-syenite and of mafic syenite where associated with included layers of amphibolite. There is no such clear cut superimposed layering as has been found to the south. It may be noted however that the major synclinal structure through Humbug and Ragged mountain on the Santa Clara quadrangle (Buddington, 1937) is uniformly quartz-syenite as compared with generally, though not consistently, more mafic facies around the anticlines.

Again if we assume that the Loon Lake is younger than the Saranac sheet and intrusive beneath it, we nowhere find any positive evidence of the Loon Lake sheet appearing beneath the Saranac sheet around the borders of the anorthosite mass. This raises the question as to whether the Loon Lake complex represents the central core of the Saranac sheet, a part where the latter is much thicker than on the exposed edge around the anorthosite domes. The Saranac sheet could be younger than the Loon Lake complex.

The Saranac and Loon Lake series of rocks have been treated in this report as members of two separate complexes each with the character of deformed stratiform sheets. As indicated, however, it is recognized that this hypothesis must be considered only a tentative one as long as there is no adequate explanation for certain phenomena such as those discussed above. One can only hope that critical evidence will eventually be found in areas as yet unmapped or by more detailed study in the mapped quadrangles.

RAINBOW STRUCTURE AND FORM OF GRANITE

Rainbow structure. Between the main anorthosite massif and the Bloomingdale syncline there is a large area in which metagabbro or amphibolite, granite and a subordinate amount of syenite are involved in structural relationships which are somewhat complex and in which so much of the area is obscured by glacial drift that satisfactory interpretation of the structure from surface exposures alone is impossible.

South of Harrietstown, a reasonable interpretation appears to be that the quartz-syenite of the west limb of the Bloomingdale syncline was much thicker than on the east. It contained a thick sheet of metagabbro parallel to the present position of Twobridge Brook. This sheet thinned out at the south. After the folding which formed the syncline, a mass of granite was intruded along the general zone of contact between the amphibolite and the quartz-syenite. It spread the quartz-syenite apart and steepened the dip of the quartz-syenite on both flanks. The granite itself acquired a foliation suggesting emplacement as a nearly vertical lense.

The amphibolite of the hill north of Jones pond extending southeast for a mile and a half from Gabriels dips away to the northeast off the syenite sheet which fringes the anorthosite dome. The granite with shreds of amphibolite on the hill north of Rainbow lake dips southwest. The opposed dips suggest a simple synclinal structure but the relationships of the dips in the rocks of the hills northwest and west of Vermontville do not fit this simple picture. Faulting may well be a complicating factor. The true relationships can not be worked out without more knowledge of the nature and structure of the rocks beneath the drift.

Granite phacoliths and lenses. The granite in the Saranac quadrangle ocurs in synclinal troughs conformable with the structure of the country rock, with the exception of the Harrietstown lense inserted along the limb of a structure. Similarly on the Santa Clara and in the north end of the St Regis quadrangle the granite occurs largely in synclinal troughs. The granite is thus developed almost wholly as phacoliths in amphibolite or in Grenville metasediments in this region.

The granite only rarely intrudes the syenite and is found in the anorthosite only as small dikes or as local pegmatitic veinings, especially in the border zones of the main massif.

The intrusion of granite into amphibolite within synclinal structures is a common phenomenon and is also well-shown on the Santa Clara quadrangle (Buddington, 1937) as well as on the Saranac sheet. The granite usually locally contains layers of amphibolite and shows all gradations between schlieren of amphibolite and disintegrated relics.

Garnetiferous amphibolites where intruded or included and modified by the granite have the garnet destroyed and reconstituted to other minerals. This suggests that the garnet was produced by metamorphism at a period before the emplacement of the granite at its present level.

METAMORPHISM AND PLASTIC FLOWAGE; ORIGIN OF FOLIATION

Practically all the Precambrian rocks of the Saranac quadrangle with the exception of the diabase dikes show a pronounced foliation and usually a linear structure. Two quite contrasting hypotheses have been developed by geologists working in the Adirondacks to explain these features of the igneous rocks. The earlier workers including Kemp, Cushing, Smyth and Newland, believed that regional orogenic stresses played a very large part in producing and controlling the foliation and linear structure within the igneous rocks as we now find them, though recognizing that there may have been an earlier primary structure of magmatic origin. Miller (1916), on the other hand, advocated the hypothesis that the foliation of the igneous rocks was primary and formed by magmatic flowage with concomitant crushing of crystallized portions during the progress of intrusion and consolidation of the magma under the impulse of the thrust and pressure of the magma against its walls and in shouldering aside blocks of Grenville gneiss.

Balk (1931) has more recently expanded and developed the idea that the movement of magma during the process of intrusion was itself responsible for the induction of the foliation and linear structure. The following excerpts discussing foliation and linear structure of the rocks of the Newcomb quadrangle are taken from Balk (1932, p. 28-29):

> If magma moved along a retarding surface which was approximately even, and if the rate of movement along the wall was approximately the same in all directions parallel to the wall, foliation only would have resulted. . . . If, finally, magma moved along an even surface, but if the rate of movement in one direction was appreciably greater than in all other directions, then both foliation and flow lines would have originated. The latter will point in the direction in which the movement of the magma was fastest. In every case the flow lines indicate the longest axis of Leith's strain ellipsoid (C. K. Leith, 1923, p. 21). . . . Both the foliation and the flow lines are primary structures; that is, have originated during the time of the final magma consolidation, and not later. . . . The exact time when foliation and flow lines originated can be brought into relation with the magmatic differentiation. In the syenite series both structures were definitely

> developed before the syenite magma produced pegmatites and before myrmekite was developed. . . . Although of essentially the same age, the flow lines have continued to form after the foliation was completely developed.

The writer (Buddington, 1939, p. 305-33) discussed this subject for the Adirondacks as a whole and arrived at the conclusions that the border facies of the anorthositic complex, the gabbroic rocks, and the members of the syenitic complexes all had a more or less well-developed primary planar structure developed before complete consolidation of the magmas from which they were derived and that upon this was superimposed a secondary foliation and linear structure as a consequence of intense deformation and plastic flowage of solid rock after complete consolidation. The granite on the other hand was interpreted as having a primary planar structure due to magmatic flowage and to deformation before complete consolidation. These conclusions appear to be applicable to the phenomena found in the rocks of the Saranac quadrangle. There are, however, certain features which appear to be inconsistent with these interpretations and the problem can not be considered as adequately solved.

The presence of an original primary planar structure of the magmatic stage is based upon its occurrence in local masses of each of the rock types which for one reason or another wholly or largely escaped the later deformation, upon the parallel orientation of disc shaped inclusions, the manner in which an older structure has in part controlled subsequent small intrusions, and upon analogy with what might be expected in bodies of such form and origin.

The Marcy anorthosite, even where it shows only a slight percentage of mortar, often shows a well-defined flow structure due to orientation of the feldspars parallel to a plane. This is beautifully exhibited in the rock at the top of Ampersand mountain. The Saranac mafic syenite, in particular, commonly has many disc-shaped inclusions with a parallel planar orientation. If a part of the differentiation of the syenitic magmas was effected through processes of gravity sorting of minerals in place a primary planar structure is to be expected, such as that which is usually found in sheetlike structures. A megascopic linear structure, however, has not been so far described from sill-like igneous masses, and this does occur in the syenitic sheets.

Except for the residual local masses of relatively undeformed rocks, it was concluded by the writer that the foliation and linear structure as we now find it in the rocks of pregranite age is wholly secondary and is due to deformation of solid rock with consequent plastic flowage and some concomitant mineralogical reconstitution. The orientation of the secondary planar structures appears to have been governed almost wholly by the orientation of primary planar structures and is parallel to them. The rocks at the time of their deformation were solid but at such depth, temperature, and in the presence of such vapors or solutions as to yield by thoroughgoing plastic flowage. During the deformation it would not be necessary for there to be more than an infinitely small percentage of the fluid phase present at any one time. Such phenomena as the development of new minerals like garnet and the unmixing of perthitic intergrowths of orthoclase and oligoclase to yield discrete grains of microcline (or orthoclase) and oligoclase all indicate that flow was in part a product of the movement and rearrangement of atoms and molecules as well as presumably by translation-gliding, twin-gliding and rotation of crystalline aggregates.

The interpretation of the secondary nature of the foliation and linear structure of the anorthositic, gabbroic and syenitic rocks as the product of plastic flowage of solid rock is based upon the following relationships in the Adirondacks as a whole. On a regional scale the trend lines of the foliation are arranged in a fashion indicative of control by tangential orogenic stresses, and on a small scale the orientation of the foliation for rocks of similar physical properties is in part "independent" of their surfaces of contact. The size of grain of the secondary granular material (mylonitic or crushed and recrystallized grains) has a systematic regional variation for rock of the same kind and primary texture, and, concomitantly, there is a consistent variation in the mineralogic facies developed. If the interpretation of the Diana, Santa Clara, Saranac and Loon Lake complexes as deformed stratiform sheets is correct, the deformation of these rocks must have occurred after their consolidation, for thorough-going crush and associated recrystallization structures are not known in sills undeformed by orogenic stress, and, in the Adirondacks sills of syenite and quartz-syenite, preserved in limestone which has acted as a cushion, are undeformed even in areas where crushing and recrystallization is otherwise intense. The trend lines of the foliation and the linear structure, the different physical facies and the different mineralogic facies for similar kinds of rock, all have a systematic regional development consistent with an interpretation of origin in terms of dynamothermal metamorphism under varying physical conditions.

Regional studies (Buddington, 1939, p. 251-303) have shown that in the northwest Adirondacks there is a succession of rock complexes similar in composition and geologic relationships to those of the central Adirondacks. The anorthosite, gabbroic anorthosite, gabbro and mafic gabbro of the anorthosite complex, the olivine gabbroic intrusives and the mafic syenite, syenite and quartz-syenite of the Diana syenitic complex in the northwest Adirondacks are absolutely free of garnet whereas their equivalents in the central Adirondacks are all at least locally garnetiferous. This will serve to exemplify what is meant by systematic regional variation caused by variant regional physical conditions during metamorphism. The rocks of the central and north central Adirondacks are thought to have been deformed under conditions of greater depth and higher temperature than those of the northwest.

In many Adirondack anticlines linear structure is strongly accentuated and planar structure becomes indistinct in the axial region and especially on the plunging noses of such folds. This has been noted (Buddington, 1939, p. 309-10) in the case of the Piseco, Jennings Mountain, Reber, and Lowville anticlinal structures. This accentuation of linear structure on the plunging noses of anticlinal foliation is also well-exemplified in the quartz-syenite of the Loon Lake series at the south end of the Katy Mountain anticline north of the Saranac river and also in the mafic syenite and the anorthosite at the north end of the St Armand anorthosite prong just south of the Saranac river. This phenomenon seems certainly to indicate formation under the control of regionally directed compressional orogenic forces.

Plastic flowage of the Grenville rocks is well-shown by the very marked thinning on the limbs and thickening in the ends of the syncline as well as by minor drag folds and by brecciation of more brittle beds which lie between more plastic members.

The microtexture of the mortar and groundmass of the anorthositic rocks, and of the amphibolite and syenitic rocks is of the mosaic type, an aggregate of polygonal grains with planar faces, characteristic of strongly deformed rocks.

There is one set of phenomena in the Saranac quartz-syenite, however, which appears to be in direct conflict with the concept of plastic flowage of solid rocks and might be interpreted as indicating that the deformation of this rock was effected before its complete consolidation. This is the common occurrence of coarse massive pegmatitic veinings both parallel to and across the foliation of the quartz-syenite. The pegmatitic seams and veins have the same color as the green syenite, a similar mineralogy, and are restricted in their occurrence to the quartz-syenite so that they may most reasonably be interpreted as genetically related to it. Such relationships are usually interpreted (Balk, 1932, p. 29-32) as meaning that the main body of the rock was not wholly crystallized when deformation took place, that the pegmatite represents the last magmatic residuum and that deformation ceased before the consolidation of the pegmatite veins. The hypothesis might be considered, however, that the veins are the product of formation during the period of metamorphism and in connection with solutions emanating from the younger granite magma during its period of emplacement. The veins in such a case would be probably in part endemic or venous pegmatites. If this were the case we might also expect to find such veinings developed in the Loon Lake quartz-syenite but this has not been noted. The problem of the proper interpretation of the origin and significance of these pegmatite veins remains an enigma to the writer and one that must await further study for its elucidation.

The actual emplacement of the granite at the level now exposed took place at a time younger than that at which all the older rocks had been subjected to an orogenesis and were folded and deformed for it transects and modifies the structures and previous nature of metamorphic reconstitution. The granite, however, may well have been subjacent and in the process of rising to the present level so that vapors from it were escaping into the overlying rocks during their deformation. The granite on the Saranac quadrangle uniformly shows a granoblastic aggregate of feldspar and elongate amoeboid to flat leaves of quartz oriented parallel to the foliation indicating that it too has been strongly deformed. It is, however, cut by pegmatite veins which in part are massive and undeformed. This seems to mean that the main bulk of the granite was deformed before its complete consolidation and that the last residual magma which went to form the massive pegmatite veins consolidated in a period of quiet after deformation had ceased.

DIABASE DIKES

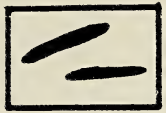
The diabase dikes strike exclusively between N. 60° E. and N. 80° W., mostly between N. 65° E. and N. 90° E. This is in accord with the strike of similar dikes in the surrounding quadrangles.

SEQUENCE OF EVENTS

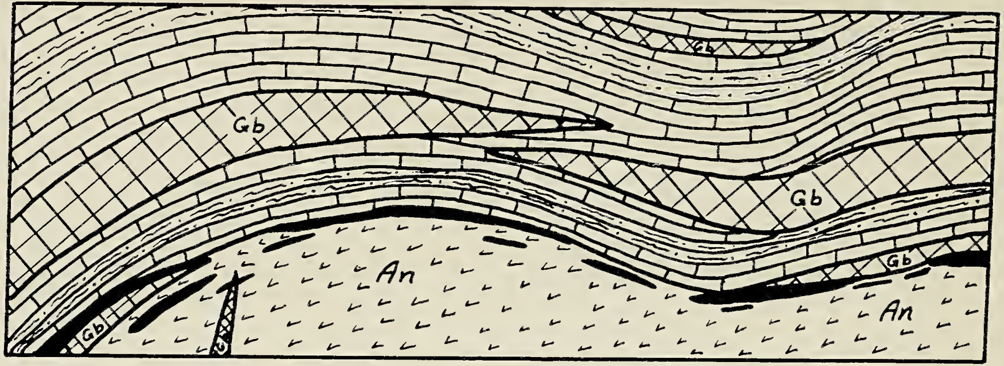
The bedrock of the Saranac area shows such a complexity of structure, and has so many of its critical contacts covered with overburden, that a satisfactory story of how it all happened has not been determined. A series of diagrams, (figure 14, A, B, C, D), however, are given herewith to illustrate one hypothesis for the possible sequence of events. Little validity is attached to the details shown, and what value the diagrams may have lies only in their portrayal of the kind of thing that is thought to have happened.

formed accompanying the intrusion of the quartz-syenitic magmas. It may be that the Tupper-Saranac sheet is younger than the Loon Lake sheet.

ANORTHOSITE AND
GABBROIC ANORTHOSITE

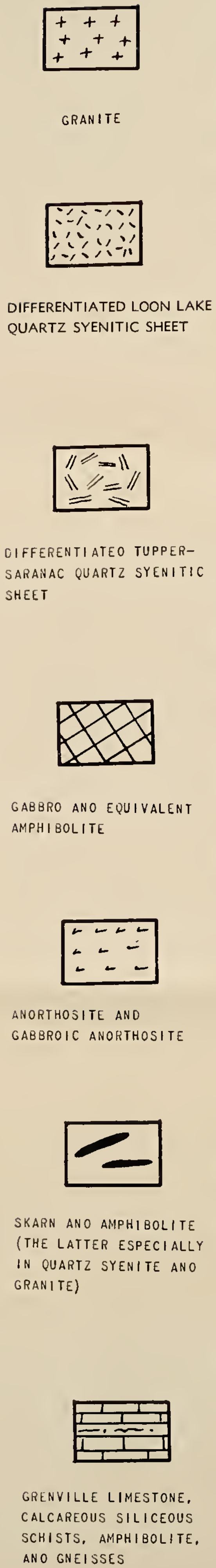


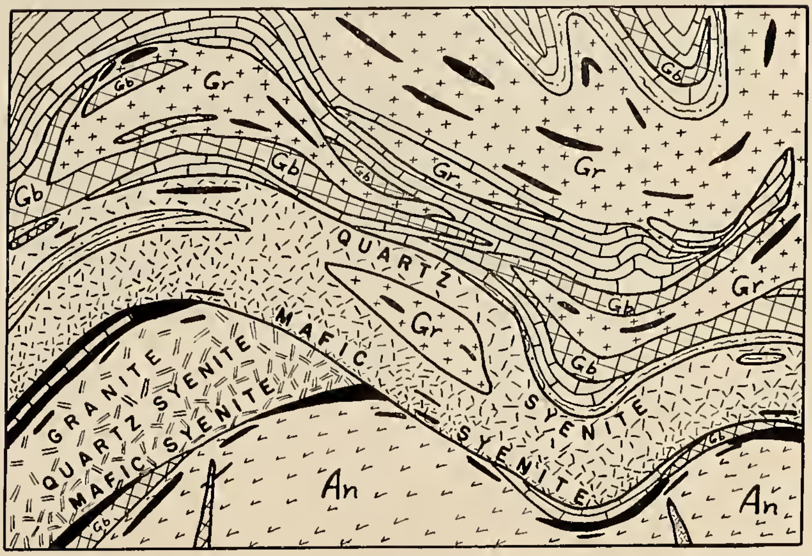
SKARN AND AMPHIBOLITE
(THE LATTER ESPECIALLY
IN QUARTZ SYENITE AND
GRANITE)



B

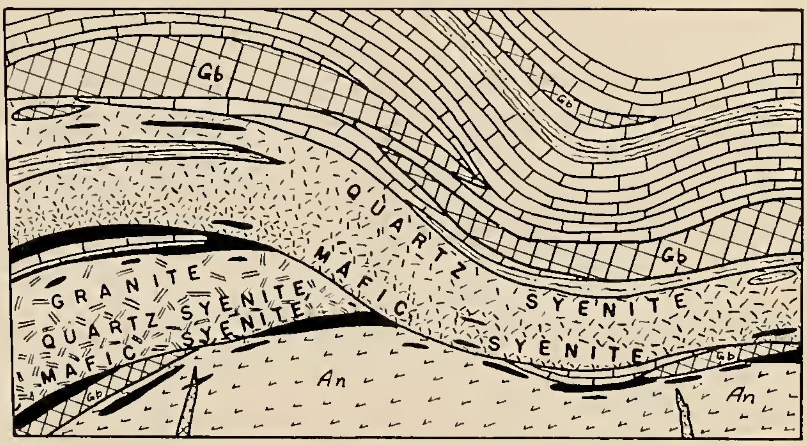
Stage II—Grenville limestone series with anorthositic intrusions and associated skarns intruded by gabbro sheets.





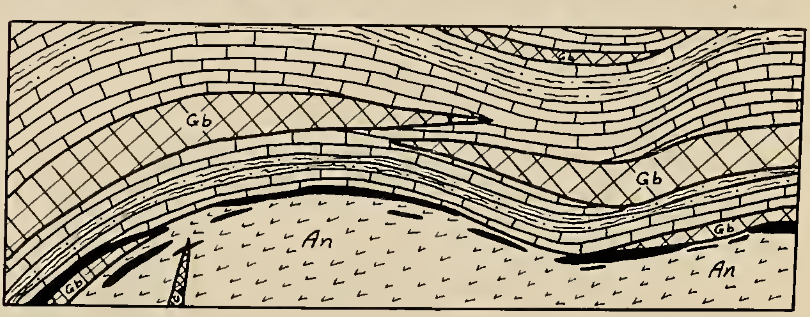
D

Stage IV—The complex of Grenville limestone series with its anorthositic intrusions and associated skarn and gabbro intrusive sheets, asymmetrically differentiated Tupper-Saranac and Loon Lake quartz-syenitic intrusive sheets and associated skarns has been subjected to compressional orogenic stresses which have moderately to intensely folded and deformed the rocks, and they have then been intruded by granite in batholithic and phacolithic forms. The granite has produced amphibolite locally from meta-gabbro and limestone.



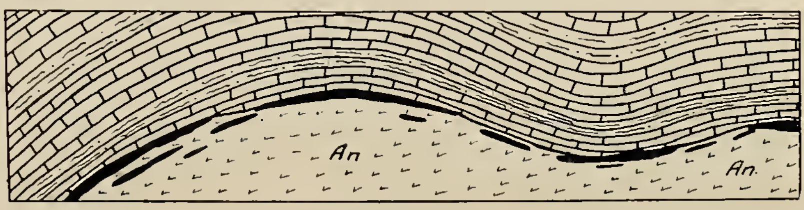
C

Stage III—The Grenville series with anorthositic intrusions and associated skarns and gabbro intrusive sheets has been intruded by two surges of quartz syenitic magma to form in succession the Tupper-Saranac and Loon Lake sheets, each so differentiated as to have quartz syenite or granite as an upper facies, and mafic syenite as a basal or near basal facies. More skarn was also formed accompanying the intrusion of the quartz-syenitic magmas. It may be that the Tupper-Saranac sheet is younger than the Loon Lake sheet.



B

Stage II—Grenville limestone series with anorthositic intrusions and associated skarns intruded by gabbro sheets.



A

Stage I—Grenville metasedimentary series with anorthositic intrusions which have produced skarn in contact zones. Grenville series only gently folded.

Figure 14—A Series of Schematic Vertical Sections to Illustrate an Hypothesis for the Major Successive Stages in the Development of Adirondack Structure

JOINT SYSTEMS

There are two major joint directions which are present throughout all rocks of all parts of the quadrangle; one ranges between N. 65° E. (commonly N. 75° E.) and N. 80° W., the other between N. 5° E. and N. 30° W. (commonly N. 10° W.). A third direction which is present throughout and locally of major significance ranges between N. 45°—70° W. A set of joints striking N. 30°—50° E. is localized in a northeast belt including Lower Saranac and Kiwassa lakes, a zone a few miles wide parallel to and east of the Saranac river to where it passes off the map. A belt in which there is a set of joints striking N. 20° E. is localized in the hills along the west side of the valley between Lake Clear and Paul Smiths. All the joints have steep dips.

The joints with a strike between N. 75° E. and N. 80° W. belong to a set which is prevalent through the northern Adirondacks. This is also the direction to which all the basaltic diabase dikes of the northern Adirondacks are parallel. The north to north northwest joint system is also a major one in the Santa Clara quadrangle.

The northeast joints of the Saranac River belt frequently are slickensided and it is probable that they are related to a fault system which has this strike in the eastern Adirondacks. Similarly many of the N. 20° E. set of joints in the belt north of Lake Clear are also slickensided and faced with a thin-filling of calcite and pyrite. They too probably indicate and are related to a zone of faulting.

The joints are the controlling factors responsible for the great cliff faces which are so common in the anorthosite of the hills and mountains. There is also a gently dipping sheeting structure in the anorthosite which aids exfoliation and is a major factor in yielding rounded dome-shaped hills. The exposures in the forest are not such as to permit observations on the prevalence and orientation of this structure without more detailed study than has been given.

FAULTS

The writer believes that there are a number of faults within the rocks of the Saranac quadrangle but in most cases direct evidence is elusive.

The discordant relationships of the structure of the St Armand anorthosite prong has previously been discussed (p. 74) as a basis for postulating two faults striking respectively a little north and a little south of west and delimiting the Ray Brook block of coarse Marcy anorthosite with vertical foliation.

There is excellent evidence of discordant structural relationships along a north-south line three and three-quarter miles east of Bloomingdale where pyroxene granite of the Loon Lake sheet is brought against mafic syenite with anorthosite inclusions of the Saranac syenite sheet. There is either an abrupt change in strike on opposite sides of the fault line as in the ridge a mile north of the County line, or there is a narrow zone of profound disturbance of the structure as south of the Saranac river.

A discussion of the origin of the Saranac Intramontane Basin in the chapter on physiography has given reasons for suggesting that it is indirectly the product of infaulting. If so the probable locus for a part of the eastern border would appear to be somewhere in the lowlands along or east of the Saranac river. Evidence for the presence of faulting here is only locally obvious from the structure. It is significant, however, that in the quadrangle joints with a N. 30—50° E. strike are almost wholly restricted to a zone stretching along the east side of the Saranac river as previously noted. Direct evidence that this belt in part at least marks a zone of faulting is found in the slickensided surfaces and profoundly disturbed rocks in the vicinity of the Saranac river two and three-fourths to three and one-half miles east of Bloomingdale. One exposure is in a roadcut just west of the intersection of the cross road, N. 40 E., with a steep south dip. Along one such slip surface there are lenses of quartz and veinlets of calcite with subordinate pyrite, a little coarse molybdenite, and sparse sphalerite.

Shingle Bay and Boot Bay mountains form a block that has steep east slopes and stands considerably higher than the normal level of the basin. They have the topographic appearance as though belonging to an isolated fault block. The geologic exposures are inadequate to definitely prove a fault but there are some exceptionally peculiar relationships in geology locally along the east base of this block which could be consistently explained by faulting.

It has been noted that in the group of hills between Lake Clear and Paul Smiths there is a joint system striking N. 20° E. which is not found elsewhere in the quadrangle. There is again a sharp topographic break and local evidences of marked discordance of structure in a belt east of this group of hills. Veinlets of calcite with subordinate pyrite occur along a number of slickensided north northeast joints. A fault or fault zone thus seems to be indicated here.

Alling (1916) had previously indicated faults along the general locus of Lower Saranac lake, Kiwassa lake, the Saranac river northeast of Saranac Lake and northeast of Lake Clear.

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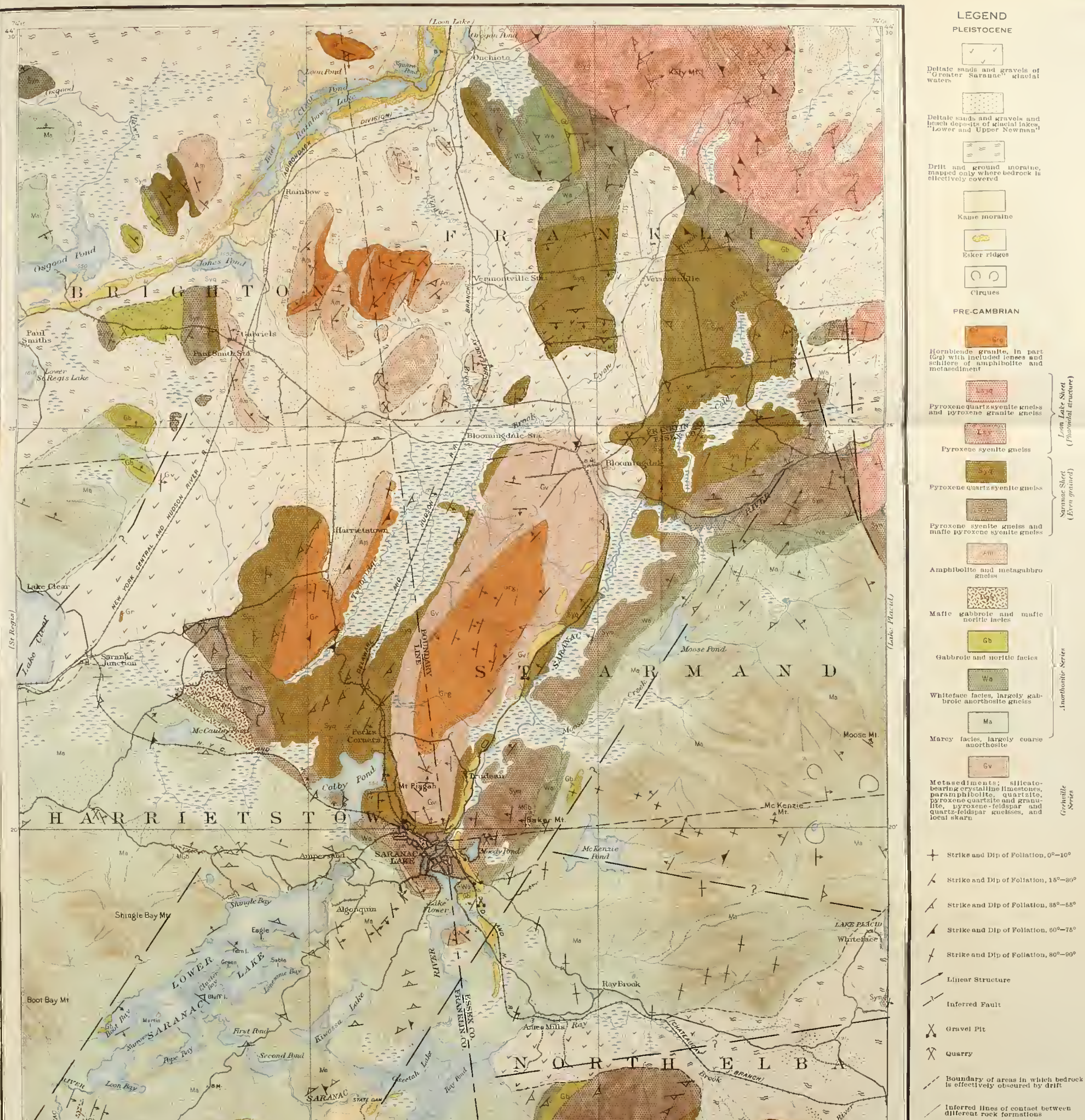

Topography by U. S. Geological Survey and the State of New York, 1902

Geology by A. F. Buddington, 1939-1941.

GEOLOGIC MAP OF SARANAC QUADRANGLE

Scale 1/62500

1 ½ 0 1 2 3 4 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 25 feet

Datum is mean sea level