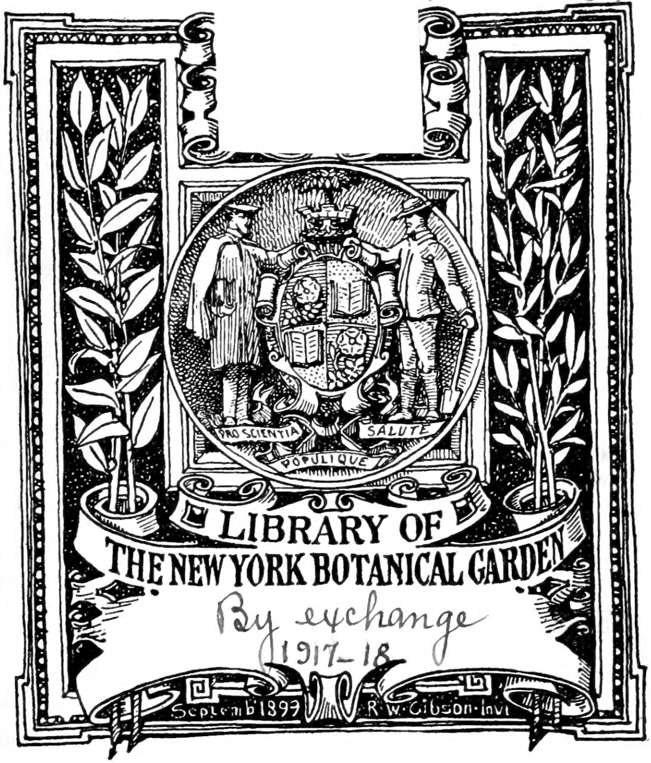
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TECHNICAL PUBLICATION No. 5
OF
THE NEW YORK STATE COLLEGE OF FORESTRY
AT
SYRACUSE UNIVERSITY
HUGH P. BAKER, Dean

# The Hardwood Distillation Industry in New York

BY
NELSON C. BROWN

Wood Utilization Series No. 1

Published Quarterly by the University

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Photograph by Nelson C. Brown.

This shows the character of cordwood in 50-inch lengths used in the wood distillation industry. Practically all of this wood is made up of mixed beech, birch and maple. It must be seasoned at least one year before being used in the distillation process. In some of the wood yards of these plants several thousand cords are seasoning. The wood is used with the bark on, and everything down to one inch diameter is frequently taken.

Over 192,000 cords of hardwood are annually consumed in this industry in New York State.

Photograph taken at the plant of the Maryland Wood Products Co., Maryland, Otsego County, N. Y.

# PREFACE

In order to meet intelligently the demand for information about the distillation of hardwoods in New York State, the New York State College of Forestry decided to carry on as one phase of its research work, an investigation of the commercial methods used in the distillation of hardwoods in the State. This industry was started and largely developed within the State. New York is still one of the leading states engaged in the distillation of hardwoods.

In writing the report, the purpose throughout has been to make the explanations as simple and clear as possible, using as few technical and involved terms as are consistent and in many instances engaging in reiteration that may at times seem unnecessary. The industry is closely identified with certain aspects of chemistry, but the author has purposely avoided a discussion of chemical changes that take place in the distillation of wood since the intent has been to make the report valuable to the wood producer and user in New York State rather than to those engaged directly in the work of wood distillation.

In the conduct of the investigation form letters were sent to every wood distillation plant in the State to obtain information upon woods used, equipment, methods and costs, daily and annual capacities and yields in charcoal, wood alcohol and acetate of lime. Personal visits have also been made to most of the twenty-five plants in New York State as well as several in other states and information has been checked up by a number of those prominent in the industry.

The author wishes to express cordial appreciation of the kindly interest shown him by those engaged in the industry. He wishes especially to express his sincere gratitude to the following men who have shown interest in the work and have helped in making necessary corrections and changes: Mr. F. A. Mason of W. A. Case & Sons, Buffalo, N. Y.; Mr. George L. Mackay, Warren, Pa., Mr. John Troy of Olean, N. Y.; Mr. E. B. Stevens of Buffalo, N. Y.; Messrs. W. S. Gray & Son of New York City; Mr. S. J. McConnell of Hancock, N. Y. and Mr. J. L. Stuart of Binghamton, N. Y.

NELSON C. BROWN.

SYRACUSE, N. Y., *November 1, 1916.*

# CONTENTS.

## History

*Introduction.*

The heating or carbonizing of wood for the purpose of manufacturing charcoal has been in practice as long as history is recorded. It is believed that it is as old as civilization itself. In the manufacture of charcoal by the old process, the wood is heated to such temperatures that it becomes carbonized while the gases that pass off in the form of dense, heavy, black smoke have given rise to the modern processes of distilling wood.

Altogether two distinct branches of the industry have been developed in this country. The most important branch is devoted to the utilization of the denser and heavier hardwoods and seeks the recovery of the following commercial products: wood alcohol, acetate of lime, and charcoal. In addition, the minor products are wood tar and wood gas, both of which are at the present time usually utilized as fuel in the heating process. Only those hardwoods that are comparatively free from an excessive content of gums, tannins, resins, etc., are desirable. The so-called northern hardwoods, such as maple, birch and beech, are considered the most suitable. Hickory and oak are also considered of almost equal value.

The other branch of the wood distillation industry requires resinous woods and the objective products are, on the other hand, turpentine, tar, wood oils, and charcoal. The southern longleaf pine is the best wood for this kind of distillation and up to the present time has been practically the only one used for this purpose. This bulletin deals only with the distillation of hardwoods in New York State.

*Early Practices.*

The first record of the distillation of wood on a commercial scale in this country is in 1830 when James Ward began the manufacture of pyroligneous acid at North Adams, Mass. This is the raw liquor distilled from the condensed vapors that pass off in heating the wood. So far as can be learned from records, it was not until 1850 that the distillation of wood for the production of volatile products and semi-refined products was begun. According to the most authentic records the first successful wood distillation plant in this country was established in New York State in 1850, when John H. Turnbull, of Turnbull & Co., Scotland, who had for some time been connected with the industry, came to this country and erected at Millburn, Broome Co., New York (now Conklin on the Delaware, Lackawanna and Western Railroad) a small chemical plant. The copper and steel castings were brought from Scotland. There were eight cast iron retorts, 42 inches in diameter and about 8 feet long, and the necessary copper stills, copper log condensers, etc. A number of men, experienced in the industry were brought over by Turnbull from Scotland and many of these men and their sons became managers of plants which soon after sprang up in southern and southeastern New York.

The retorts were charged each twelve hours with wood cut in eight foot lengths. The vapor was condensed in a copper log condenser and the liquid recovered was pumped into settling tanks, from which it was drawn to the copper stills for distillation. The settled tar was drawn off from these settling tanks each day, and spread with a ladle over the charcoal, which was burned under the retorts, the copper and lime stills, and the pans — all distillation being accomplished by this direct method. Little or no effort was made to save the wood spirit, the main object being to produce acetate of lime, for which a high price was obtained both in the home and Scotland markets.

The methods followed in operating the plant demanded a large amount of hand labor, and sturdy men of experience were needed to carry the work forward. These men with their families, came from time to time from Scotland. In a short time Millburn became known as the Scotch Settlement and it was famous for the number of trained men who, after getting their experience here were called upon to take charge of distillation plants not only in New York but in Pennsylvania, Michigan, Canada and other centers as well.

About 1865 (or soon after) a Mr. Pollock, a chemist, of Morrisania, New York, began refining wood spirit in a small way. The market developed rapidly. Shortly the Burcey Column was introduced to the crude plants, thereby adding to the power of the stills to recover wood spirit of 82 per cent. test. The production of wood spirit being greatly increased, it became desirable to install a central refining station, and the Burcey Chemical Co., with a refinery at Binghamton, New York, resulted. A refinery was also started in Brockton, Mass. in 1877.

For a long time the sale of charcoal was limited, the greater part being consumed as fuel in the plants. Slowly the market developed, until to-day practically the entire output is shipped, hard and soft coal taking its place under the boilers and retorts, and live steam being used in the stills (now fitted with coils), and in the pans, which have steam jackets at the bottom.

At the present time, plant operation is along efficient lines. Old time methods have been discontinued, and the manual labor is now greatly reduced. In the woods there is also a noticeable improvement. Cord wood is now to some extent cut from the limbs and refuse tree trunks, after the lumberman has taken out all the best timber in the shape of logs.

Thus the danger of fire is reduced and the ground, which otherwise would be covered with scattered brush, is free for new seedlings to take root without delay, or the stumps left to sprout up with a new wood crop.

## Utilization of Wood in the Industry

*Favorable Conditions in New York.*

New York State forests are very fortunately located for the carrying on of the wood distillation industry. It has three very necessary conditions for successful operation, namely: (1) a plentiful and therefore a relatively cheap wood supply; (2) comparatively near a good fuel supply, such as natural gas and coal; (3) reasonably accessible to a market for the products of the industry. The only desirable condition that is not present is that of large iron furnaces where the charcoal can be utilized to the best advantage.

New York State contains an unusually good supply of native woods for use in the wood distillation industry. The highlands of the southeastern part of the State, the Alleghany plateau of the southern part of the State and the lower elevations of the Adirondacks, embracing a considerable portion of northeastern New York, contain splendid stands of beech, birch and maple and in the former two regions these and other species sprout to excellent advantage. In fact, many areas have been cut over at rotations of twenty years where the cut showed an annual growth of one cord per acre per annum. This rate of growth is as good as can be expected under the best forest management.

*Desirable Species.*

Woods that are hard and heavy are the most suitable for the wood distillation industry, especially those that are, in addition to the above qualifications, free from tarry and resinous products. As a rule, heartwood is considered much more desirable than sapwood and there is an almost uniform opinion among manufacturers to the effect that hard maple is considered best and that beech and birch follow in order. Chestnut contains too much tannin for successful production of distillates. Ash, oak and hickory are considered almost as good as the so-called northern hardwoods, namely, beech, birch and maple. Cherry and elm contain too much tarry material and consequently the distillate results in an excessive amount of wood tar which has very little commercial value and in addition there is an insufficient yield of alcohol and acetate of lime. Basswood, popple, cottonwood and the soft woods or conifers are entirely too soft and light. The conifers such as spruce, white pine, balsam, fir, hemlock, etc., are undesirable on account of the resinous nature of their wood and their light weight. Other native species found in New York do not grow in sufficient quantities to make them of any importance for use in the industry.

*Stumpage Values*

The value of the timber on the stump varies considerably. On large logging operations where the tops, limbs, defective trees and brashy material are utilized, practically no stumpage value is used, because the utilization of this material is considered as salvage. On most of the New York operations steep, rocky hillsides, covered by the desirable hardwoods are anywhere from one-half mile to several miles from the plant or shipping point. Stumpage on these operations, particularly in Delaware county, which is the center of the industry in New York State, runs about 75 cents per cord. Altogether it varies between 25 cents to $1 per cord. There is a general tendency for stumpage values to rise. This has been especially true during the past decade. Since the European War broke out, the stumpage values have been inflated to a considerable extent.

*Cutting and delivering to the factory.*

Cutting is done by choppers who in many sections, particularly in Delaware county, look upon getting out the annual cord wood supply in the winter as a lucrative means of winter employment. The trees are cut up in fifty inch lengths and hauled on sleds when snow is on the ground or on wagons directly to the acid plant. Hauls up to eight to ten miles are fairly frequent.

For cutting and stacking, the usual figure is about $1.25 to $1.40 per cord. Cutting is usually done by contract, and where the wood is favorably sized and located for chopping and the ground fairly level, cutting and stacking can be done as low as $1 to $1.10 per cord by experienced choppers. The maximum figure is about $1.50 per cord. The cost of hauling varies with the distance and the character of the ground and the road over which the load is hauled. One and one-half to two cords are usually considered the maximum load under the most favorable conditions. The total cost of wood delivered at the commercial plants is about $4 per cord. Estimates obtained from all the New York plants show that the average value of cordwood delivered at the plants is $4.06 per cord. The maximum cost was estimated to be $5 per cord at one plant. At another plant, the cost was estimated to be $3.25 per cord, which was the minimum estimated cost in the State.

*Seasoning.*

In all cases the wood must be seasoned for at least one year before being used in the ovens or retorts. If used green, the high moisture content is excessive and too much heat is required to derive the product. At many of the plants it is estimated that before seasoning, the average cord of mixed beech, birch and maple weighs in the neighborhood of 6,200 pounds. After seasoning the average cord weighs about 3,800 pounds. The wood is used in the process with the

Photograph by Nelson C. Brown.

General view of the Keery Chemical Co. plant near Cadosia, Delaware County, N. Y. This view was taken from a sprout stand of timber cut over for "acid wood." This stand has been cut over on three different rotations. A growth equivalent to approximately one cord per acre per annum was determined to be the average yield. The timber was made up almost entirely of hard maple, beech, and birch. This is a six oven plant having a daily capacity of 60 cords. It is one of the few plants in the State which has a refinery to turn out 95 to 98 per cent wood alcohol. The wood yard is shown on the extreme right. The cooling ovens are shown on the extreme left. The refinery is the tall building in the center of the picture.

The wood in the foreground is left to season for at least one year before being used in the distillation process.

bark on. All forms of limb and body wood down to two inches in diameter are utilized. When over eight inches in diameter the wood is commonly split. Body wood is much preferred to limb wood because the latter contains too much sapwood and consequently more moisture. As mentioned previously, yields from heartwood are much greater than those from sapwood.

*Opportunities for utilization of sawmill and woods waste.*

Some of the most successful plants in this country are operated where woods waste consisting of tops, limbs, crooked trees, defective logs and broken material in the woods can be profitably utilized. Haul roads, skidways and railroads maintained and operated for the purpose of getting out logs can be utilized to excellent advantage in getting out the other material for distillation purposes, and under these conditions the wood can be delivered at the factory at a very low comparative cost. This is the method usually followed in connection with the large distillation plants in Michigan and Wisconsin and is also followed to some extent in the Adirondacks and other parts of the State. Where the larger logs are utilized for lumber, the material that would otherwise be wasted, is used for wood distillation purposes. This feature constitutes an important contribution to the cause of forest conservation because one of our greatest problems of forestry in this country is the utilization of our enormous waste. At present we waste as much as we utilize, and any form of forest utilization which contributes to closer utilization may be highly commended. The removal of all of this material from the forest also means that the fire danger is greatly lessened.

The larger refuse from the manufacture of lumber in sawmills is used to advantage in the largest plants in this country in Michigan. It is believed that this form of utilization of sawmill waste will come into greater prominence in

New York State. Only the larger forms of sawmill waste, such as slabs, edgings, trimmings, and similar material can be utilized to commercial advantage. The sawdust, shavings and similar material usually cut up by the slasher cannot be utilized profitably except as fuel, but experiments are now being undertaken which may permit of the utilization of sawdust and shavings for distillation within a short time or as soon as some promising experiments can be perfected on a commercial basis.

*Management of timber lands.*

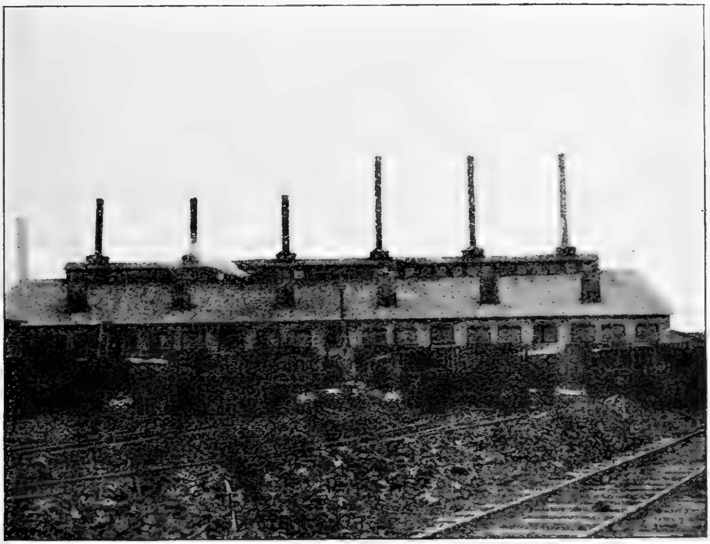
Several of the wood distillation companies in New York own tracts as large as 50,000 acres each or lease tracts nearly as large. These are managed on a permanent basis and carefully protected from the annual ravages of fire during the dangerous dry seasons. These companies are practicing one of the best forms of forestry because they utilize the products of the forest most completely, the maximum growth of the forest is stimulated, and forest fires, the greatest enemy of the forest, in so far as practicable, are eliminated. The rougher and more mountainous portions of Delaware county are admirably suited to forest culture on account of the steep, rocky hillsides which contain many springs and seepage flows, thus permitting the most rapid growth of timber and stimulating the sprouting capacity in all of the larger trees. The cutting is usually done in the winter time. The following spring the stumps sprout up thriftily and vigorously to a height of from five to ten feet the first year. After a period of from twenty to thirty years the stand is cut over and the same process is repeated. In one section four different age classes of timber were noted where average yields of one cord per acre per year had been obtained after the original forests were cut over. These tracts are in much better condition than they would be under ordinary conditions of lumbering because the forest is renewed both from sprout and from seed. The vigor of the forest is therefore maintained, forest fires are kept out and all of the available wood product is utilized. It would be a highly desirable situation if all forest industries could be run on the same basis.

*Statistics of wood consumption in New York.*

For a long time New York was the leader in the consumption of wood in the hardwood distillation industry. In the early nineties, however, the industry spread into Pennsylvania, and the greatest consumption at present is found in Michigan where, although there are comparatively few plants, the total consumption of wood exceeds that of any other State. From an investigation carried on in the spring of 1916, the State College of Forestry has determined that the annual consumption of hardwood for the industry in New York at that time was 192,330 cords. The daily capacity as reported by these plants was 643½ cords. These figures have been compiled as a result of both the daily and annual capacities of the twenty-five plants in the State, as estimated by the plants themselves. The latest available statistics as compiled by the Bureau of Census at Washington, D. C., for the consumption of hardwoods in New York State in this industry was for 1911, for which year it was announced that 132,400 cords were consumed.

The largest plant in the State in the spring of 1916 consumed 80 cords per day. This was an 8-oven plant located in Delaware county. The smallest plant in the State was one consuming only 12 cords per day in Sullivan county. This was an old cylinder retort plant containing 8 pairs of retorts. The average daily capacity of the individual New York plant is 25.74 cords and the average annual capacity is 7,691 cords.

As a rule the oven retort plants are much larger in daily capacity than the round retort plants. The smallest oven retort plant is a 2-oven affair consuming 16 cords per day with an 80 cord plant per day the largest. The smallest



Photograph by Nelson C. Brown.

One of the largest wood distillation plants in the country located at Cadillac, Mich. In the background are shown the oven houses with a smoke stack for each of the six 52 foot ovens. In front are shown the first set of cooling ovens, then the second set of cooling ovens, and finally the trucks containing charcoal cooling in the open in the foreground. This plant has a daily capacity of 96 cords, and uses chiefly mill waste from one of the large saw mills at Cadillac.

Photograph taken at the plant of the Cadillac Chemical Co.

round retort plant also consumes 12 cords per day with the largest one consuming 30 cords per day.

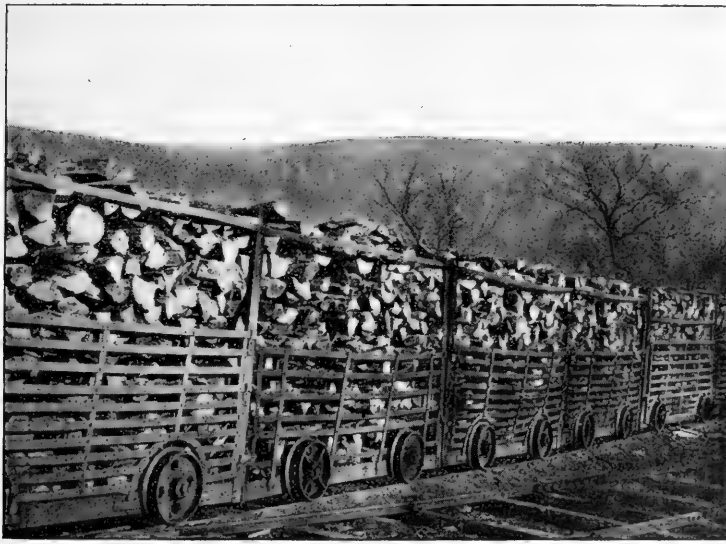
*Statistics of wood consumption in the United States.*

The latest available statistics of wood consumption in the hardwood distillation industry in the United States were for 1911, when it was reported that 1,058,955 cords were consumed. Of this amount Michigan with 13 plants led with 396,916 cords; Pennsylvania was second with 50 plants consuming 364,539 cords, and New York third with 25 plants consuming 132,400 cords. Seventeen other plants scattered in 11 different states, chiefly in the east, reported a consumption of 165,100 cords.

It is very likely that with the stimulation of high prices for products of the wood distillation industry, due to the great European War, the total consumption in the whole country in hardwood distillation amounts to about 1½ million cords, although this is a very rough estimate. The following table shows the statistics of wood consumption for the United States as compiled by the United States Bureau of Census from the years 1907 to 1911, inclusive:

| Year | Number of Establishments | Number of cords of hardwood consumed |
|---|---|---|
| 1907 | 100 | 1,219,771 |
| 1908 | 101 | 878,632 |
| 1909 | 116 | 1,149,847 |
| 1910 | 117 | 1,257,917 |
| 1911 | 105 | 1,058,955 |

This table shows how the consumption of the wood in the industry dropped off after the enactment of the Federal law in 1907 which resulted in the serious drop of prices obtained for the crude wood alcohol.



Photograph by Nelson C. Brown.

Wood cars loaded and ready to be sent into the ovens. Each 52 foot oven contains four of these trucks. Each truck contains between 2 and 2½ cords of 50 inch wood. In the process of distillation this wood is reduced about one-half in quantity to its final form as charcoal.

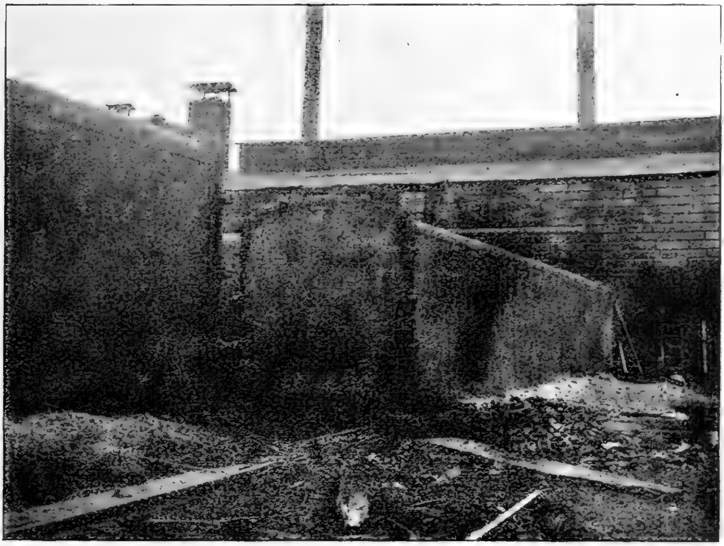
Photograph taken at the Maryland Wood Products Co. plant at Maryland. Otsego county, N. Y.

## Developments in the Industry.

Up to nearly 1860 practically all of the acetate of lime used in the dye business in this country had been imported from Europe. Acetate of lime was the principal product sought after in wood distillation in the early developments of the industry. The distillate was not utilized for wood alcohol or for any other purpose than for lime acetate, and the charcoal was used, when convenient, for fuel for manufacturing pig iron and for other purposes. Acetate of lime was commonly used even in the wet condition before it had been thoroughly dried out. In the early days of the industry it brought as high as 18 cents a pound even in the wet condition. At the present time (October, 1916), dry gray acetate of lime is bringing 3½ cents a pound, whereas in the fall of 1914 it was only bringing 1½ cents a pound. In the spring of 1916 it brought 7 cents per pound.

Mr. Patterson was one of the first men to establish a plant in New York, located at Kirkwood, near Binghamton. Mr. Thomas Keery entered the business with him at Keeryville, between Cadosia and Apex, in Delaware county, and this firm has been in the business ever since. At that time the brown acetate of lime was full of tar and not nearly equal to the present refined product. The charcoal and alcohol were usually allowed to go practically to waste. Enormous prices were obtained for acetate of lime so that interest was greatly stimulated in the industry.

About 1885 the raw form of wood alcohol was developed and an attempt was made to sell it at the hat manufacturing industries at Danbury, Conn. This was one of the very first large fields for the use of wood alcohol, and it brought high prices. Formerly grain alcohol had been used to stiffen hats and the use of wood alcohol rapidly came into common practice. At first as high as 70 cents a gallon was paid for this wood alcohol.



Photograph by Nelson C. Brown.

Oven house in the background, the first cooling oven in the center, and portion of the second cooling oven on the left. After being heated to a high temperature for 24 hours, the cars of hot charcoal are moved from the oven house to the first cooling oven. After remaining in this cooling oven for 24 hours, they are moved into the second cooling oven where they remain for another day.

Photograph taken at the Beerston Acetate Co. plant, Beerston, N. Y.

Charcoal developed as the price of acetate went down. Acetate of lime was used to fix the color in dyes, particularly in Fall River, Mass. Gradually a big influx of wood distillation plants came in and the prices gradually dropped. Around 1885 to 1900 there were a great many small capacity plants and most of them followed very rough and crude methods. All of them used the cylinder retort process. These plants, however, were gradually replaced by the larger modern plants using the long oven instead of the old retort. There is now a much smaller number of plants than formerly, but, on the other hand, there is a much greater annual consumption of wood in the industry, due to the economy in plant operation with the advent of the oven in the early nineties.

Up to 1900 the industry was almost wholly centralized in the State of New York. At that time a few plants were started in Pennsylvania just over the border from the southern tier of counties in New York. About 1902 to 1906 the industry was further developed in Michigan, where the largest wood distillation plants, some of them utilizing as much as 110 to 200 cords of wood per day, are now located. Ideal conditions are present for the successful manufacture of wood distillation products in Michigan because of the availability of the raw material in connection with hardwood, saw and planing mills, together with the fact that iron furnaces are maintained in connection with them where the charcoal can be used to the best economical advantage. In addition the raw material is secured from the waste of sawmills and logging operations and one of the principal products can be utilized on the ground without excessive shipping rates.

Before 1907, wood alcohol had been bringing from 38 to 40 cents per gallon wholesale for the crude product, that is. the 82 per cent crude alcohol. When the Federal Internal

Revenue Department removed the tariff on grain alcohol, which took effect September 1, 1907, the price of crude wood alcohol dropped to about 16 cents per gallon, and gradually came back to 26 cents. The approximate present price is 45 cents per gallon, a price stimulated largely by the European War conditions. Before the war the price was about 28 cents per gallon of crude 82 per cent alcohol.

## Processes of Manufacture.

Within the past fifty years the developments in the processes of manufacture followed in hardwood distillation have been remarkable. The history of the industry represents an evolution from the old wasteful charcoal pits. To recover the condensible gases lost in making charcoal by the old pit process, brick kilns were used. This was a very crude process, but represented a great step in advance. Next came the round iron retorts placed in " batteries " of two each in long bricked-up rows, and within comparatively recent years the steel oven, which is a great labor and time saving device. The following are brief descriptions of these three processes which followed each other in rapid chronological order.

### *Brick Kilns.*

The brick kilns supplanted the old charcoal pit as a means of manufacturing charcoal when the iron industry in this country assumed large proportions. Brick was substituted for the open air sod or clay covered pit because manufacture was simplified, the loss of carbonization was minimized, and burning, therefore, could be carried on with greater safety. However, a good portion of the vapors are lost with the brick kilns as they are with the old open air pit since the yield is only about 40 per cent to 50 per cent of the yield from the oven process. These brick kilns are made with a circular base, with holes in the base for drafts of air regulated by special doors and the vapors are drawn off by exhausters through wooden ducts. This practice was followed especially in Pennsylvania and in Wisconsin, where an abundant supply of the desirable hardwoods was found in a location near blast furnaces where pig iron was produced. Pig iron, manufactured by the use of charcoal is considered far superior to that made by coke. The pig iron made with charcoal commonly bring about $5 a ton more than that manufactured with coke. The brick kilns were usually built to hold 50 to 90 cords each and were charged and discharged by hand. The complete manufacture of charcoal by the brick kilns including charging and discharging required from 15 to 25 days. The heating necessary to distill the wood is supplied by the combustion of part of the charge within the apparatus, in the same way that charcoal is made in the open air pit. The yield of charcoal by this method is somewhat below that manufactured in the retorts or ovens and is generally considered inferior in grade. The brick kiln is only desirable when the chief product is charcoal and transportation facilities are not available or the market is too distant for the other products of wood distillation, such as wood alcohol and acetate of lime. Where other forms of fuel, such as natural gas and coal are out of the question and the manufacture of charcoal is desired, it is also commonly used.

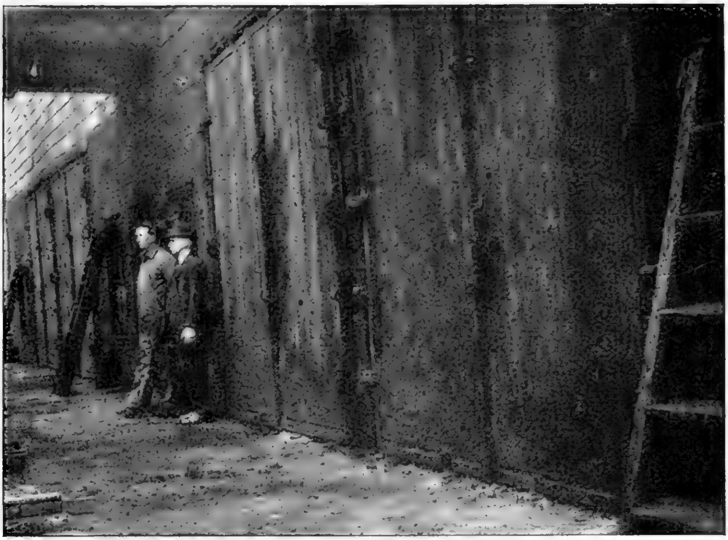
Most of the brick kilns in operation are in Michigan and Wisconsin, where charcoal is in great demand in connection with iron furnaces. There are no brick kilns operating in New York at the present time for the manufacture of charcoal.

*Iron Retorts.*

The iron retort followed the brick kiln and was the first device invented whereby the vapors from the carbonization of wood are collected on an efficient basis and distilled in the form of pyroligenous acid and later refined into wood alcohol, acetate of lime, etc. The yields, however, are much lower on account of slow firing. These retorts were small cylindrical vessels originally of cast iron and later steel cylinders 50 inches in diameter by 9 feet in length. They were placed horizontally in pairs and batteries of 10 to 15 pairs were common in long brick rows in the earlier plants. Each retort was sufficiently large to hold about five-eighths of a cord of wood. Heating was provided externally by a fire box located underneath the retort. For fuel, coal, charcoal, wood gas, wood oil, wood tar, and wood itself, have been used. The retorts are built and discharged from the single door in front which can be fastened tightly and sealed with clay to prevent the entrance of oxygen after the heating process is started. Along the top of these rows of retorts the surface is bricked over and serves as a drying floor for the acetate of lime. A run, that is the period from the first charging of the retort to the removal of the charcoal after the process, usually requires from 22 to 24 hours.

*Oven Retorts.*

The small round retort is now being rapidly replaced in the larger and more progressive plants by the large rectangular retort or oven retort. This is also known as an oven. Up to about 1900 a large number of these round retort plants were in operation, but about 1895 the oven retort came in which provides for loading and unloading the retort by the use of cars which are run directly into the chamber. This resulted in a considerable saving of labor charges so that all of the new plants now being constructed are introducing the ovens. In several of the states, there are not as many plants active now as there were twenty years ago, but there is a vastly larger amount of wood being consumed per plant, due to the fact that the oven retorts can consume as high as 10 to 12 cords in a single oven, whereas the old round retort held only about five-eighths to 1 cord of wood.



Photograph by Nelson C. Brown.

Twin doors in front of ovens. When these are opened after the distillation process is completed, the trucks of charcoal are pulled by cable into the first cooling ovens which are to the immediate left of the picture. In the background on the left are shown the doors of the second battery of ovens. This is a four oven plant.

Photograph taken at the Beerston Acetate Co. plant, Beerston, N. Y.

The modern hardwood distillation plant, therefore, is usually the oven retort plant. This was a decided advance in the manufacture of wood distillation products. As noted above, it is largely a labor saving device, and although the initial cost is considerably greater the operating charge per cord is so much smaller than with the round retort that it is being universally introduced. The ovens are rectangular in cross section and may be anywhere from 25 to 56 feet in length. The common form is an oven 52 feet in length, 8 feet 4 inches in height and 6 feet 3 inches in width. These ovens are usually arranged in pairs similar to the process followed with the round retort. The cars, each loaded with about two cords of wood, are run in on standard or narrow gauge tracks directly into the ovens. They are heated in a manner similar to the round retorts, that is, by means of a fire box underneath, although there may be fire boxes at one or both ends, and the fuel in the Pennsylvania and southern New York regions is usually either coal or natural gas. In the Delaware county section the fuel consists of coal from the Scranton region. The vapors pass out from one or two large openings at the side or at the end and are condensed through a large copper condenser. The process of distillation requires from 22 to 24 hours with the oven retorts, and when the doors are unsealed and opened, a cable is attached to the first car and they are drawn from the ovens directly into the first cooling oven which is of the same type of construction and shape as the heating oven. The capacities of the oven plants vary with the number and size of the ovens. In the Lake States there are some oven plants that now consume as high as 200 cords a day. The largest plant in New York State has 8 ovens which consumes 80 cords of wood per day and has an annual capacity of 24,000 cords.

Whereas the charcoal is emptied from the round retorts into round containers, sealed tightly to cause the slow cooling of the charcoal without admission of oxygen, the charcoal after the heating process is completed in the oven retorts is left in the cars and drawn into the first cooling oven and left for 24 hours. This is of the same type and construction as the charring oven. The cars containing charcoal are then drawn into second coolers where they remain for 24 hours; then left in the open air 48 hours, so that there is a period of 96 hours which lapses between the time of the completion of the heating process and the time when the charcoal is loaded on the cars. It must remain on the freight cars at least 12 hours before shipment so that 108 hours lapse to the time of final shipment. This precaution is taken to prevent fire, which frequently causes the loss of charcoal and cars in transit.

*Distillation.*

Although many changes have been introduced in the manner in which the wood is heated for distillation purposes, very few changes have been made within the last twenty years in the refining of the crude distillate.

In the modern oven retort operation the process requires from 23 to 26 hours for completion. When the wood is rolled in trucks into the ovens, the doors are hermetically sealed and the fires are started underneath. In from one to two hours the wood is sufficiently heated up so that water distillation takes place. This distillate contains about 2 per cent acid. Then the "green gas" comes free for about five to six hours.

It is considered desirable to heat up the wood gradually and also to let it cool off gradually at the end of the process. The exothermic process, that is, that part of the process in which the wood fibers break down under the intense heat, does not take place until the temperature is run up to about 300 degrees Fahrenheit. In about six hours after closing the

Photograph by Nelson C. Brown.

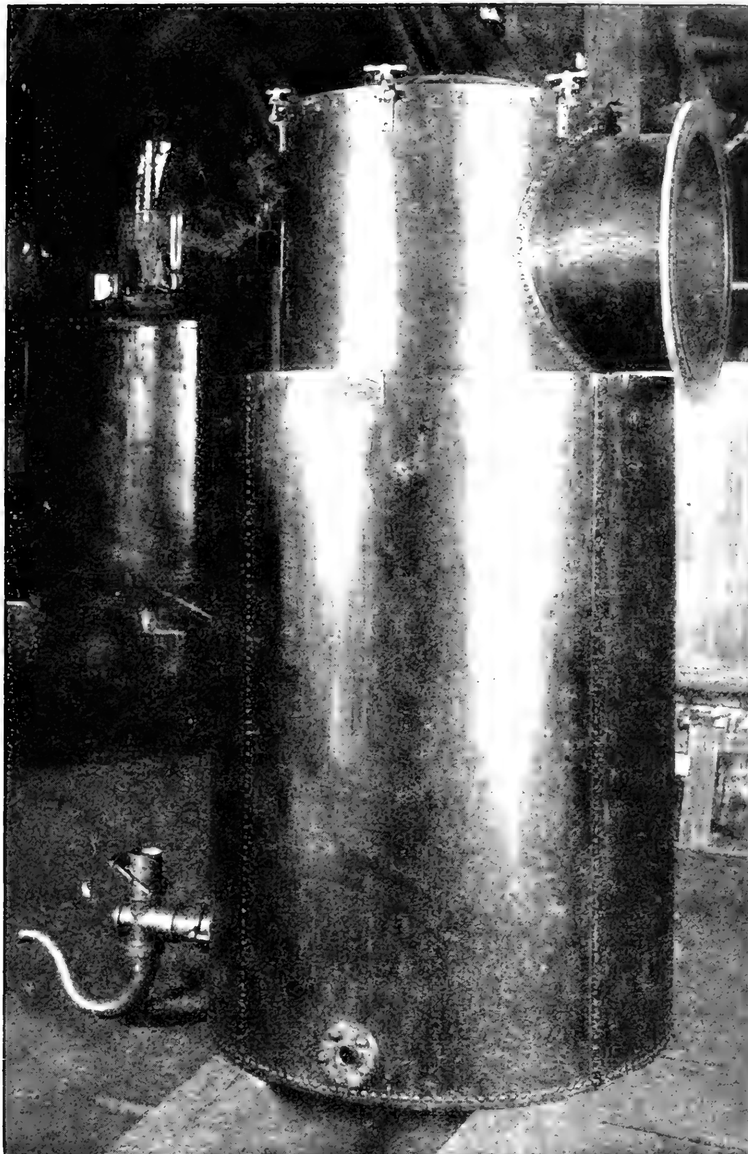
Looking down the alley between the first and second sets of cooling ovens on the shore of Lake Cadillac, Cadillac, Mich. After cooling for 24 hours in the ovens to the right, the trucks of charcoal are pulled by means of a cable into the cooling ovens on the left. Each cooling oven is 52 feet in length and holds four trucks at one charge. Note the standard gauge tracks between the cooling ovens and the manner in which the dirt is piled around the base of the cooling ovens to keep them air tight.

Photograph taken at the plant of the Cadillac Chemical Co., Cadillac, Mich.

doors the temperature attains an average of about 450 degrees Fahrenheit. It is then maintained between 450 and 600 degrees Fahrenheit. Temperatures of over 600 degrees Fahrenheit are considered undesirable. After about six hours of heating the pyroligneous acid begins to flow, and the best average is maintained up to about the eighteenth hour. An operator can determine from the color of the pyroligneous acid whether there is too much heat maintained, and if the wood fibers have broken down sufficiently. At the end of the heating process, the distillate forms tar to a large extent. After about the eighteenth hour the latent heat in the oven settings is sufficient to complete the process to the end, but the heat is gradually decreased until the charcoal is withdrawn.

As the gases and vapors pass out through the nozzle of the oven, they are condensed into a yellowish green, ill-smelling liquor called pyroligneous acid. A copper run takes this condensate to the raw liquor " sump," a tank in the ground, and so placed that the liquor will run into it by gravity. Meanwhile, the " fixed " or noncondensible gas is trapped and taken off at the outlet of the condenser and used for fuel underneath the boilers or ovens or perhaps both. A simple goose neck is used to trap off the gas.

The pyroligneous acid is next pumped from the " sump " in the ground to a series of wooden settling tubs of which there should be at least five in number. These tubs are usually from five to eight feet in diameter and six to eight feet in height. The purpose of these tubs is to settle the tar and heavy oils. The heavy tar is taken to a wooden tar still equipped with a copper condenser. This tar still is of wooden construction because the tar would eat up the copper in about a year. The residue remaining in the tar still is utilized together with residue from primary stills as boiler fuel.



Photograph by The Matthews Northrup Works, Buffalo, N. Y.

The Modern Oven Condenser.

This is placed at the rear or side of the oven and the gases are condensed through this into the raw liquor called pyroligneous acid and wood tar.

The pyroligeneous acid is then run by gravity to the primary steam-heated copper stills equipped with automatic feed in order to supply the still continuously. The residue or boiled tar which gradually fills up in the still from the bottom is distilled by itself and run off at intervals of a few days or whenever the deposit reduces the flow of distillate from the still. During this process, which is known as "tarring down," the distillate is run into a separate tank and the light oils which rise to the top are drawn off. The acid liquor is then piped to storage tanks or tubs with the regular run from this still. These copper stills are made in any size which will give them the most flexible operation, that is, the size is determined by the question of economy in operation in labor cost. This in turn depends upon the capacity of the plant in cords of wood. The vapors from the copper still are conveyed through a large copper neck to an all copper tubular condenser encased in a steel water jacket. The flow of distillate from these condensers is piped to storage tubs.

From the storage tubs the acid liquor goes to the liming or neutralizing tubs. These are wooden tubs 12 feet to 14 feet in diameter, about 4 feet high, and provided with an agitator operated by a shaft and bevel gear from the top. The liquor is neutralized by adding slacked lime, a small quantity at a time. The proper quantity of lime is commonly determined by the color of the liquor, which changes at the neutral point between an acid and alkaline substance to a wine color, followed by a straw color and the appearance of beads on the surface.

From the neutralizing tubs the liquor is pumped or forced by means of a steam ejector to the "lime lee" stills. These stills are constructed of steel plate, the heat being applied by copper steam coils. The alcohol vapors pass off through an iron or copper neck, and are condensed in a copper condenser, and piped to storage tanks.

When the alcohol has been distilled off in the lime lee stills, the residue or acetate solution is forced by steam or air pressure to a settling pan located over the carbonizing ovens. After the impurities settle and are drawn off the acetate liquor is run into a large shallow steam jacketed steel pan, and boiled down to the consistency of mortar; it is then shoveled out and spread on brick, steel or concrete kiln floors over the ovens and thoroughly turned and dried; it is then shoveled into sacks for shipment as acetate of lime.

The alcohol liquor from the lime lee still is drawn from the storage tanks previously mentioned into a steel alcohol still provided with copper steam coils, and distilled off through a copper fractionating column consisting of a series of baffle plates having a tubular water cooled separator at the top. By this process the lower proof products are thrown back for further distillation, while the more volatile vapors pass over through a condenser, the distillate being sold to the refineries as finished crude alcohol of 82 per cent proof.

## Plant Equipment.

The equipment of a modern hardwood distillation plant demands a comparatively large initial investment. They are usually located with reference to a large available supply of hardwoods which can be brought to the factory at a comparatively low cost per cord. From 10 to 40 acres are usually required for the plant and its adjoining storage yards and trackage facilities. The modern plant has from 2 to 8 oven retorts which are usually 52 feet long and housed in a retort house; open space for two sets of cooling ovens; a shed for the cooling and shipment of charcoal and the still house and power plant which are usually separate from the retort house. Most of our modern wood distillation plants in New York cost from $50,000 to $500,000 for the initial investment.

Before the European War it was usually estimated that a complete plant, aside from timber lands and the woodyard, would cost $2,000 per cord of daily capacity. Since the war this average has risen to $2,500 per cord. However, this may vary about $2,000 and $3,000 per cord, depending upon the degree of completeness, cost of transportation, labor costs, character of the machinery and materials installed, etc. This means that an 8-oven plant with approximately an 80 cord daily capacity will cost in the neighborhood of $200,000. Using these same figures, the smallest modern oven plant with only two ovens and with a daily capacity of 20 cords, will cost in the neighborhood of $50,000.

A plant with seven 25-foot ovens built about fourteen years ago cost in the neighborhood of $125,000 fully equipped.

The following is a brief description of the principal features of equipment that are usually found in the hardwood distillation plants of New York State:

*Storage Yards.*

The storage yards should be in the close vicinity of the retort house and connected with it by standard gauge tracks running through the stacks of piled cordwood. The storage yards should consist of between 5 and 20 acres, depending upon the capacity of the plant and should be slightly raised in elevation above the retort house so that the loaded cars can be rolled easily into the ovens as needed.

Inasmuch as the wood must be seasoned for between 1 and 2 years, it is necessary to have a large, convenient and well-located wood yard so that there should be at least 6 month's seasoned supply on hand all the time.

At a 35-cord capacity plant it is planned to have 10,000 cords of wood as an advance supply continually on hand.

The wood is usually cut in 50-inch lengths and stacked in long piles up to 12 feet in height on either side of the standard gauge tracks from which the unseasoned wood is unloaded from freight cars. In other cases parallel roadways are left open for the wagons to unload directly from the woods. Parallel tracks between these roadways are then provided to load the wood cars for the ovens after seasoning. In cylindrical retort plants the wood is commonly rolled in on wheelbarrows or open trucks and loaded by hand.

*Retort House.*

The retort house is the largest building in the plant. It houses the cylindrical retorts or oven retorts and in some cases the stills and appliances for treating the pyroligneous acid as well. However, in the most modern plants, the still house is a separate building.

The principal requisite of a retort house is that it should be of fire-proof construction on account of the very inflammable nature of charcoal and wood alcohol. One retort house at a plant having a daily capacity of 38 cords, is 60 feet in width by 240 feet long, 20 feet high to the eaves and 40 feet to the peak of the roof. Steel beams and supports are used throughout with sheet iron roof and siding. Other retort houses are either built of stone or brick in order to reduce the fire hazard and therefore obtain low insurance rates. Most of the New York plants are poorly arranged because of their enlargements from rather modest beginnings and no definite plan seems to have been followed in the arrangement of the plant.

*Trackage and Cars.*

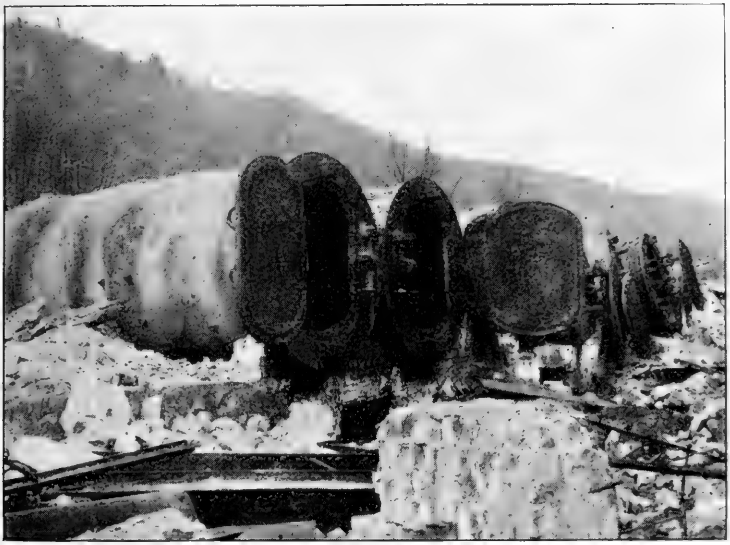
The tracks are usually standard gauge with the rails from 40 to 75 pounds in weight and are so arranged as to bring the wood from the storage yards to the retort house and then to conduct the cars loaded with charcoal through the two sets of cooling ovens and out to the charcoal shed where the charcoal is loaded on freight cars. The most modern plants have the progressive arrangement, that is, the loaded cars come from the storage yards directly to the retort house; follow through in one continuous direction to the first cooling oven and then to the second and on out to the charcoal sheds where the charcoal is shipped. The return tracks take the empty cars back to the storage yards where they are reloaded and the same process followed out.

The cars are all of steel construction and hold from 2 to 2½ cords of 50-inch wood. A 50 to 54-foot oven will hold 4 of these cars in one charge. A 25-foot oven will hold 2 of them. They are built in different sizes but the usual style of car is 52 inches wide, 6 feet 6 inches high and 12 feet 6 inches long with 4 small wheels. They first came into use in the middle nineties and have proven to be a great success.

The cars cost from $80 to $140 apiece, f. o. b. at Warren, Pa. They last indefinitely according to most of the operators, so that there is very little depreciation charge on them. Both sides of the car are detachable to facilitate the loading and emptying of the cars.

*Retorts.*

The old iron retort was a cylindrical vessel holding about five-eighths of a cord. The standard size was 50 inches in diameter by 9 feet in length. Cordwood 48 inches in length was used instead of the 50-inch length commonly used in the oven retorts. The retorts are set in brick work in pairs, each pair forming a battery and heated directly from beneath. They are charged and discharged from a single door in front which can be hermetically sealed. Considerable labor is involved in the charging and discharging of these retorts and the ovens with the cars running directly into them on tracks are a great improvement. With the invention of the ovens in the early nineties very few of the old round retorts were installed. In fact, all of the new plants being developed in New York State have the long oven retorts. At the present time there are 352 retorts distributed over 15 plants in different parts of the State.



Photograph by Nelson C. Brown.

Cylindrical retorts of an old-fashioned retort plant, now burned down and dismantled. These retorts are arranged in batteries of two and are heated by direct heat underneath. Each retort contains about $\frac{5}{8}$ of a cord and must be loaded and unloaded by hand. The modern oven is a vast improvement over this old-fashioned method.

This photograph was taken at the Keery Chemical Co., Cadosia, N. Y.

*Ovens.*

The oven or oven retort is a vast improvement over the round retort, the chief advantages being that a large amount of wood can be distilled at one time and considerable labor is saved in charging and discharging the ovens, the loaded wood cars being run directly in from one end on tracks and hauled out by means of a cable on the other end to the first cooling oven.

These ovens in cross section are 6 feet 3 inches wide and 8 feet 4 inches high. In length they vary from 25 feet to 50 feet, although the usual length used at the present time is a 52-foot oven which holds 4 cars. These ovens are usually installed in batteries, that is, 2 ovens being placed close together and called a battery. In Michigan there are as many as 7 to 10 batteries in a single plant. The largest New York plant contains 8 ovens and is located at Corbett in Delaware county. Altogether in New York State there are 46 ovens distributed over 10 plants.

These ovens have air-tight doors on one or both ends, depending upon whether the charcoal is to be taken out in the same direction as it entered or sent out through the progressive form of trackage arrangement. The ovens are of steel, usually three-eighths of an inch in thickness, while the bottoms and backs are of one-half inch material. The oven is sustained by means of angle irons riveted perpendicularly on the sides and on one side near the top are riveted cast iron nozzles, usually two in number, which are attached to the condensers. In the heating process it is said that the 52-foot oven will expand 4 inches in length due to the tremendous heat applied during distillation. These ovens only last from 3 to 12 years, so that the depreciation charge is very high.

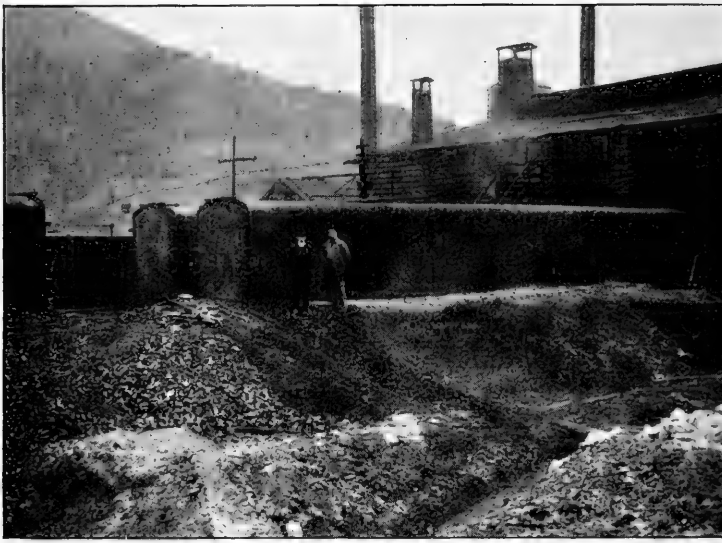
The 52-foot oven costs about $1,800 and approximately an equal amount is required to install and set it up ready for operation.

*Cooling Ovens.*

In every oven retort plant the charcoal is gradually cooled by being run into cooling ovens located immediately in front of the retort house in the open air. The first cooling oven is about 8 to 10 feet from the charring oven and the second cooling oven about an equal distance beyond the first cooling oven. The accompanying photographs show the arrangement of the cooling ovens in relation to the retort house. The cooling ovens appear to be the same in size, shape and construction as are the ovens themselves. However, the sides are only of three-sixteenths inch steel and usually there are doors at both ends. There are no bottoms to these cooling ovens as they rest directly on the ground. Dirt is piled around the base to prevent the admission of air.

The cars with the heated charcoal, after the distilling process, are rolled directly into the first cooling oven. As soon as the air is admitted on the opening of the doors, the charcoal bursts in flame and as soon as possible after the cars are rolled into the cooling oven the doors are hermetically sealed, so that the charcoal will cool slowly. The charcoal is left for 24 hours in the first cooling oven, 24 hours in the second cooling oven, then is left at least 48 hours in an open shed or in the open air and after being loaded on the freight cars it is left standing for at least 12 hours before shipping. This means a total of 108 hours from the time of heating to the time of leaving the yard. A government regulation prescribes this procedure because " punky " knots hold fire for a long time in the charcoal and it is necessary that these extreme precautions be taken to prevent burning of the cars.

In some of the plants, an outlet pipe is used near the top of the cooling oven to permit the escape of the acid fumes. It is claimed by some that this saves the eating of the iron by these fumes.



Photograph by Nelson C. Brown.

General view of the plant of the Beerston Acetate Co., Beerston, Delaware county, N. Y. On the right is shown the oven house containing four 52-foot ovens. In the center is shown a battery of cooling ovens into which heated charcoal is drawn in trucks and left standing for 24 hours. The end of the second cooling oven is shown on the extreme left.

*Still House.*

The provision for redistilling the pyroligneous liquor is usually housed in the old plants along with the cylindrical retorts but in the more modern oven plants the apparatus is placed in a separate fire-proof building usually in close proximity to the power house or in connection with it.

The equipment of the still house consists principally of the settling tubs, neutralizing tubs, storage tubs, steam pans, copper and iron stills, condensers, fractionating column, etc., required for the three principal distillations previously described. Although the equipment in some small details may vary in each plant, the general process of separating the acetate of lime and the wood alcohol as well as the wood tar, is the same as was in common practice about 20 years ago.

For each separate plant, however, individual plans are drawn up to meet the requirements of local conditions. Altogether it is estimated that the equipment of the still house costs between $430 and $500 per cord of daily capacity. In the description of processes of manufacture, the function of the various equipment in the still house is described.

The following is the usual equipment used or recommended for a hardwood distillation plant consuming 30 cords of wood per day:

Retort condensers including tubs and outlet connections, number and size depending upon style of retort or oven installed.

Copper liquor run for conducting raw liquor from condenser outlets to storage tub.

Copper gas main and connection for conducting wood gas from condenser outlets to boiler for fuel.

5 wooden setting tubs for raw liquor from storage tank above mentioned.

1 copper still complete with copper steam coils, neck and condenser for first distillation of raw liquor. Wooden storage tubs for liquor from copper still.

Wooden liming tub with power agitator for neutralizing liquor from storage tubs above mentioned.

1 iron lime lee still fitted with copper steam coils and condenser (an iron neck may be used on this still).

Photograph by The Matthews Northrup Works, Buffalo, N. Y.

The primary or raw liquor still with condenser and neck. This is one of the most modern and approved forms of stills and condensers.

1 or 2 steel storage ranks for lime lee liquor.

1 steel alcohol still with copper steam coils, column, separator and condenser for producing 82% crude alcohol from lime lee liquor above mentioned.

Steel storage tank and one large steel shipping tank for raw liquor. The residue from lime lee stills (acetate of lime) would be piped to the open steel settling tank and then to steam pan. The acetate of lime would then be shoveled from steam pan to drying floor on top of ovens if possible in order to utilize waste heat from ovens.

The use of a small wooden tar still with copper neck and condenser for distilling raw tar from settlers which contain a considerable quantity of alcohol is also recommended.

For refining the crude alcohol further one would require one steel still with copper steam coils, refining column, separator and condenser for first distillation; one steel still with copper steam coils, column of different type than used in first distillation including separator and cooler for second distillation. The alcohol in first and second distillation is treated with caustic soda. A steel tank graduated in inches or gallons should be provided for caustic soda storage and charging stills.

2 steel storage tanks would be required for each still, each tank having the capacity equal to still.

An all copper still with copper steam coils, refining column of special type including separator, cooler, hydrometer jar, necks, etc., complete would be required for third distillation. The alcohol would be treated with sulphuric acid in this distillation. Suitable storage and shipping tanks which may be of steel to be provided for finished goods.

This latter outfit would produce commercial refined alcohol of 95% to 97% purity.

*Drying Floor.*

The drying floor is a flat, level space surfaced with cement or concrete usually placed over the ovens. The heat of the ovens furnishes the necessary temperature to dry out the acetate of lime. After being dried it is bagged up and shipped directly in freight cars.

*Charcoal House.*

The charcoal house is usually an open-constructed affair slightly elevated above the level of the oven house so that the cars containing charcoal can be unloaded directly into box cars or into charcoal bins. The trucks containing charcoal must be left either in the open air or standing in the charcoal house at least 48 hours before the charcoal can be dumped into the box cars. Most of the charcoal is shipped in the loose state. Sometimes it is separated into as many as five grades, the finer product being bagged and shipped in sacks containing 25 or 50 pounds each. In all cases the charcoal house is well removed from the oven house to decrease the danger from fire. It is also well protected by means of hose, water pails, fire extinguishers, etc., to minimize the fire hazard.

*Cost of Plant and Equipment.*

As outlined before, the initial cost of a modern complete wood distillation plant is very large. It is estimated that under present market conditions an investment of $2,500 should be provided for each cord of capacity. That is, if a plant is so designed to be of 50 cords capacity, the initial investment required would probably be about $125,000.

Before the great European war, it was generally estimated that a complete plant would cost about $2,000 per cord of capacity. The difference in the above estimates is due to the fact that the cost of iron, steel, copper and other materials used in the manufacture of wood distillates, have risen tremendously as a result of the competition to better conditions in this country, together with a demand for supplies from European countries.

The old fashioned cylindrical retort plant is much less expensive for the initial expense but the heavy charges due to labor result in excessive operating charges. A 24-round retort plant, that is, one containing a battery of 12 pairs with each pair of retorts holding about 1¼ cords, costs $75,000 for the entire plant.

When it is figured that the modern plant costs $2,500 per cord of capacity, it is estimated that one-third of this charge is for buildings, while the apparatus costs about two-thirds.

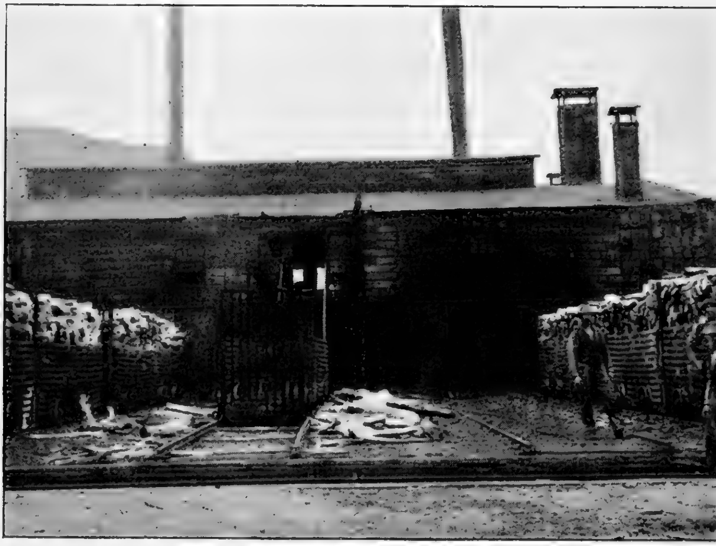
## Plant Operation.

The following are the principal features of plant operation. Each is briefly described, giving the principal commercial features involved, such as costs, per cord charges, and other commercial features involved in the operation of a wood distillation plant.

*Fuel.*

Altogether there are six forms of fuel commonly used in the hardwood distillation industry. They are as follows: Coal, natural gas, charcoal, wood, wood tar and wood gas. Altogether coal is most commonly used. In the district centering around Olean many of the plants use natural gas. Most of the plants in the Olean district, however, are just over the New York line in Pennsylvania. The plant at Vandalia is the only one in the district in New York State. Both hard and soft coal are commonly used for the purposes of direct heating and the production of steam. Most of the Delaware county plants use coal. Practically all of the plants in the State use the wood tar and wood gas, which are products of the distillation process, directly under the ovens or retorts or under the boilers.

The estimates regarding the cost of fuel vary considerably. Altogether estimates were received from $1.15 to $2 per cord. The cost will naturally vary with the kind of fuel used, the distance from source of supply, efficiency of boilers and steam pipes and other correlated factors. In one of the larger plants of the State which has seven 25-foot ovens, it was estimated that 300 bushels of charcoal, 300 gallons of wood tar and all of the available wood gas were used for each charge of seven ovens. At a prominent plant in Delaware county it was estimated that 300 pounds of soft bituminous coal were used for the distillation of one cord of wood. In an oven containing ten cords, therefore, this would require 3,000 pounds of soft coal for one charge. It is estimated that



Photograph by Nelson C. Brown.

Cars loaded with seasoned wood ready to be pulled into the ovens, the doors of which are shown at the oven house. The ovens are charged every 24 hours. This illustrates the progressive arrangement, the cars after the distillation process being pulled out the farther side into the cooling ovens.

Photograph taken at the Beerston Acetate Co., Beerston, Delaware county, N. Y.

the fuel value of wood tar is at least twice as much as that of coal for a given weight.

*Labor.*

Labor is a very important item in the cost of production. Altogether the labor is unskilled at all of the plants with the exception of the plant superintendent or manager, and in the case of the largest plants there is a chemist or expert engineer employed who receives more than the ordinary day wages. There is a distinct tendency to raise wages at the various plants. At the present time these vary between $1.50 per day to $1.60 at one plant up to $2 per day at others. All plants, of course, run night and day but there is a very small force engaged in the work during the night time. At most of the plants there is a given piece of work to be done each day, and when this is completed the men are free for the rest of the time. For instance, in the wood yard, the day's work may consist of loading so many cars of wood. When this particular work is completed, the men are through for the day.

Altogether the larger the plant the greater is the economy in labor. The greatest saving in labor in the development of the industry, has been the change from the old round retort plant to the modern oven plant. Owing to the fact that the trucks are pulled in and out of the oven by means of a power cable, there is a great saving in labor over the old round retort plants where the retorts had to be loaded and discharged by hand.

At a 4-oven plant having a capacity of 40 cords per day, there were the following employees:

2 firemen at the boilers.
2 men in the still house.
2 firemen for the ovens.
4 men in the dry-kiln.
4 men to charge and draw extra trucks or cars.

1 extra man about the piping.
2 men in the wood yard, handling wood.
1 foreman.

This makes a total of 18 men on the 24-hour shift, that is, there are 13 men on during the day and 5 during the night. This list does not include the teamsters used in drawing the wood from the chopping area to the storage yards.

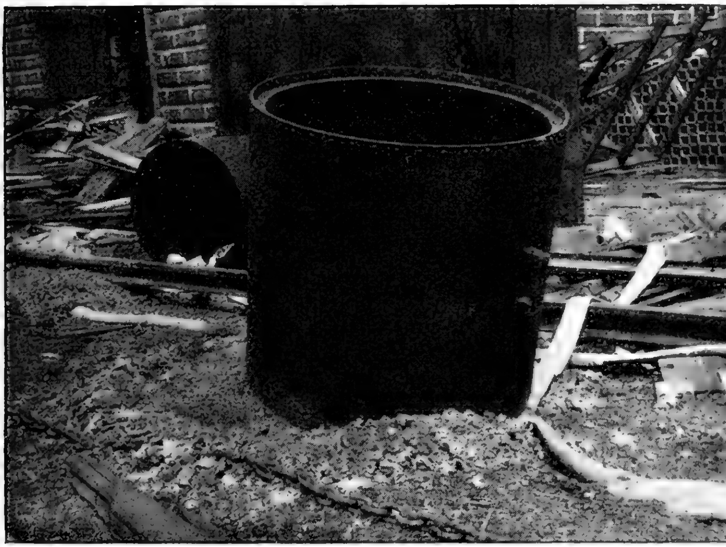
At a 2-oven plant there were 12 men employed beside the superintendent. All of these men were common labor paid at the rate of $1.50 per day. The firemen were on 8-hour shifts and all others were on 10-hour shifts. The following shows the number of men required on this particular operation:

2 still house men, one on the night, and the other on the day shift.
2 kiln men, one on the night and one on the day shift.
3 firemen in 8-hour shifts each.
3 oven men to load wood on cars or coal screener.
3 extra handy men.

The labor cost per cord varies very much. In two plants the costs were $1.15 and $1.18 per cord respectively. At other plants the labor cost is sometimes as high as $1.50 to $1.70 per cord. The labor charge is considerably higher, of course, in the cylindrical retort plants than in the oven plants due to the reasons given above.

*Depreciation Charges.*

Owing to the intense heat required to distill the wood, and the acid nature of the products, depreciation charges on the ovens, retorts, cars and distilling apparatus are very heavy. Ovens usually last only from 3 to 12 years. The coolers last much longer as a rule and the wood cars last from 12 to 20 years. Altogether a depreciation charge of from 50 cents to



Photograph by Nelson C. Brown.

Charcoal cooler used in the old cylindrical retort plants. The charcoal was shovelled from the retorts directly into this container and kept in an air-tight condition to prevent combustion. In the modern plant the charcoal is now cooled in the same truck in which it is heated, the trucks being run into cooling ovens on standard gauge tracks.

Photograph taken at the dismantled retort plant of the Keery Chemical Co., Cadosia, N. Y.

$1 per cord is customary at most of the plants. However, the usual charge is likely to be nearer $1 than the lower figure.

The life of the copper apparatus is about 10 to 12 years and there is considerable salvage on old copper.

*Cost of Operation.*

The cost of operation depends on a large number of factors, the chief of which are the charges for wood, fuel and labor. Transportation charges for material such as fuel, supplies, etc., are also an important consideration.

It is very difficult to say what the average costs of operation should be. They are usually figured or based on the charges per cord. At the various plants, the method of cost computation varies considerably so that it is very difficult to compare one with another. The degree of efficiency also varies considerably as it is very difficult in this respect to compare them. At an oven retort that has been run for some time in Delaware county, the costs per cord were figured as follows:

| | |
|---|---|
| Wood | $4.00 |
| Labor | 1.50 |
| Fuel | 1.77 |
| Lime | .19 |
| Supplies, oils, etc | .32 |
| General expenses | .51 |
| Depreciation | .58 |
| Insurance | .08 |
| Taxes | .22 |
| Total | $9.17 |

The above computation was based on a month's run and a very careful record was kept of all costs. There were 16 men employed at this factory, not including the men engaged in cutting and hauling the wood, nor the office force. The standard wage scale was $1.60 per day and the factory was located in the region in which a plentiful supply of wood could be obtained.

At another oven plant the following costs were observed. These are also given per cord of wood.

| | |
|---|---|
| Wood | $4.00 |
| Fuel | 1.50 |
| Labor | 2.00 |
| Depreciation, etc | 1.00 |
| Marketing | 1.47 |
| Total | $9.97 |

*Yields.*

The yield of products at hardwood distillation plants varies considerably. The yield at any particular plant depends upon the following factors:

1. Temperature, that is, the maximum and minimum temperatures used during the exothermic process.

2. The rapidity of heating. Too rapid heating will cause a much smaller and lower grade of product. Usually about 10 hours is the time required to get wood up to the highest temperatures. If heating is done too rapidly the color of the pyroligneous acid is much darker and the yields are consequently much lower.

3. The species of wood. There is a general consensus of opinion among the New York plants, that maple is the best wood with beech next and birch third. Oak and hickory are also desirable species but if there is too much soft maple, basswood, poplar, gray birch or other inferior species, the yields will be lowered.

4. The character of the wood. It is generally assumed that the dryer and more thoroughly the wood is seasoned, the

better will be the product. It is also true that heart wood yields much larger and better products than sapwood, and body wood is much more desirable than limb wood.

5. Efficiency of the plant. This is determined by the character of the machinery and equipment, arrangement of the apparatus and many other factors connected with the efficiency of an operation.

The products of hardwood distillation in New York State are as follows: wood alcohol, acetate of lime, charcoal, wood tar and wood gas. The latter two are practically always used as fuel under the boilers or retorts.

From an investigation of the 25 plants in New York State it was determined that an average yield of 42.7 bushels of charcoal are obtained per cord of wood from all of the plants. There was a maximum yield of 50 bushels of charcoal per cord and a minimum yield of 38 bushels.

The average estimated yield of acetate of lime was 199.47 pounds per cord of wood. The minimum was 171 pounds and the maximum 220 pounds.

In wood alcohol the average yield was 9.9 gallons of 82% wood alcohol per cord of wood. The minimum was 8 gallons and the maximum 11 gallons per cord.

It is estimated that between 23 and 28 gallons of wood tar are secured per cord with an average of about 25 gallons. It is estimated that about 11,500 cubic feet of gas are secured per cord of wood.

These figures are based upon the individual estimates of the various wood distillation plants of the State. Altogether much better yields are secured from the oven plants than from the cylindrical retort plants.

*Value of Products.*

One of the greatest drawbacks to engaging in the wood distillation business has been the great fluctuation in the price

Photograph by Nelson C. Brown.

End view of a pair of cooling ovens showing the character of the door, lugs and method of heaping dirt around the base to prevent the entrance of air. The trucks loaded with the heated charcoal are drawn directly from the oven-house into the first cooling oven and left there for 24 hours. They are then drawn into the second cooling oven for another 24 hours. After that, the charcoal stands in the trucks in the open air for 48 hours, after which it is loaded on the freight cars where it remains 12 hours before it is sent off to its destination.

These cooling ovens are kept air tight to prevent combustion of the heated charcoal.

Beerston Acetate Co., Beerston, Delaware county, N. Y.

levels for all of the principal products, namely, acetate of lime, wood alcohol and charcoal.

In the early days of the industry, charcoal was the principal product and it brought from 10 cents to 20 cents a bushel or more. Then acetate of lime became the principal product sought after and finally the wood alcohol. Before the Federal legislation, the profits were very excellent and attractive but since 1907 and up to the outbreak of the great European war on August 1, 1914, price levels were very uncertain and several of the concerns were driven out of business.

Up to the time of this war, the prices obtained for acetate of lime varied between $1.25 to $2 per hundred pounds. Since August 1, 1914, the following price levels have been obtained:

| | | |
|---|---|---|
| August to October | 1914 — | $1.50 per 100 lbs. |
| November | 1914 — | 1.75 per 100 lbs. |
| December | 1914 — | 2.00 per 100 lbs. |
| January | 1915 — | 2.00 per 100 lbs. |
| February to May | 1915 — | 2.50 per 100 lbs. |
| June to August | 1915 — | 3.50 per 100 lbs. |
| September to October | 1915 — | 4.00 per 100 lbs. |
| November to December | 1915 — | 5.00 per 100 lbs. |
| January | 1916 — | 6.00 per 100 lbs. |
| February to August | 1916 — | 7.00 per 100 lbs. |
| September | 1916 — | 5.00 per 100 lbs. |
| October | 1916 — | 3.50 per 100 lbs. |

In regard to wood alcohol, the prices have also fluctuated considerably. Quotations varied between 30 cents and 45 cents per gallon for the crude 82% alcohol. Since the outbreak of the war, however, the use of both wood alcohol and acetate of lime have been greatly stimulated for their use in the manufacture of certain war munitions and the prices have steadily advanced.

During the year 1914 the market price of 82% crude wood alcohol was 25 cents per gallon delivered to the refineries in tank cars and the price of 95% refined delivered to buyers in free wooden barrels to points east of the Mississippi river 45 cents per gallon in 1 to 10 bbl. lots and a small discount in carloads. Prices held at these figures until October, 1915, when the price of 95% refined wood alcohol began to advance first to 50 cents, later to 55 cents, then on February of 1916 to 65 cents, and on October 1, 1916, to 70 cents, the price of crude steadily advancing to the present figure of 45 cents per gallon. These advances were made possible by the rapid increase in the price of denatured alcohol, this material now being 60 cents per gallon. There is every indication that the price of both alcohols has gone sufficiently high for some time to come. In the spring of 1916, 97% refined alcohol brought 70 cents per gallon. Methyl acetone was worth 90 cents to 95 cents per gallon and pure methyl or columbian methanol was worth $1 a gallon.

With the increased use of both acetate of lime and wood alcohol, the demand for charcoal has not kept pace with these other two products, and consequently prices have suffered very materially. At the present time, charcoal is only bringing around 5 cents to 6 cents per bushel. In 1914 it was bringing 7 cents a bushel wholesale at the acid factory. The estimated production of charcoal in this country before the war broke out, was about five million bushels a month and the iron furnaces took by far the greatest proportion of this.

Practically all of the products of the wood distillation industry are sold wholesale in carload lots at the factory. The wood alcohol is shipped in tank cars or in tight barrels. Charcoal is shipped in sacks and the acetate of lime is also shipped in sacks or bags. Up to the present time, no regular market has been developed either for the wood gas or wood tar. Both of these are usually now consumed as fuel underneath the retorts. It is very likely that some time in the future a definite market will be developed for the utilization of wood oils and wood tar. It can be made into creosote but the process is so expensive that this form cannot compete successfully with coal tar creosotes.

The following table shows a comparison of values of products per cord under conditions prevailing in 1914, and those occurring in 1916. This table is based upon the average of yields of acetate of lime, wood alcohol and charcoal per cord. The values are those described before. The following table shows that the operators were receiving more than twice as much for their products under market conditions in the Spring of 1916 than they did under those prevailing before the war.

| | Yield per cord | Value per unit 1916 | Value per cord 1916 | Value per unit 1914 | Value per cord 1914 |
|---|---|---|---|---|---|
| | | *Cents* | | *Cents* | |
| Acetate of lime.... | 199.47 lbs. | 7 | $13 97 | 1.7 | $3 39 |
| Wood alcohol..... | 9.90 gals. | 37 | 3 66 | 25. | 2 48 |
| Charcoal......... | 47.7 bu. | 6 | 2 86 | 7. | 3 34 |
| | | | $20 49 | | $9 21 |

## Utilization of Products.

The utilization of the products of the hardwood distillation industry has been a great problem, especially since the Federal law of 1907 went into effect. The greatest money return is received from disposal of the acetate of lime and the prices received for this product have undergone great fluctuation.

Altogether there are three primary products derived from the process, namely, the raw pyroligneous acid, the wood gas and the charcoal which remains as a residue from the distillation of the wood. The secondary products as a result of the separation of the tar from the pyroligneous acid and the further distillation of the pyroligneous acid, are first, wood tar, second, acetate of lime and third, wood alcohol.

The utilization of the five derived products of this industry, therefore, are described in the following order: acetate of lime, wood alcohol, charcoal, wood tar and wood gas.

*Acetate of Lime.*

During the year 1916, it is estimated that in New York State there will be produced 38,396,835 pounds of acetate of lime. This is based upon the annual consumption in New York State of 192,330 cords with an average yield of 199.47 pounds of acetate of lime per cord. At a valuation of seven cents per pound this material is worth $2,685,788.

It is estimated that approximately 100,000 long tons of acetate of lime are produced every year in this country. Under normal conditions, that is, before August, 1914, only about 75,000 long tons were produced.

Under normal conditions the export and domestic consumption of acetate of lime about equalled each other. Now this product is chiefly consumed in this country.

Probably 75 per cent of the acetate of lime produced in this country is used as the raw material for the acetic acid industry. More recently there has been a tremendous demand for the use of acetate of lime as a source of acetone. About 100 pounds of 80 per cent acetate of lime are equivalent to 50 to 60 pounds of refined acetic acid or 20 pounds of acetone. Acetic acid is used chiefly for the manufacture of white lead, acetone in the textile and leather industries and in a great variety of other commercial manufactures. One of the most important present uses is in the manufacture of cordite and lyddite, two high explosives. Acetone is also used largely as a solvent for the cutting of gun cotton and in the manufacture of smokeless powder.

In many of the European countries acetic acid or wood vinegar is a common product on the market. However, the manufacture of wood vinegar from acetic acid is prohibited in this country.

*Wood Alcohol.*

During 1916 it is estimated that there will be produced 1,904,067 gallons of 82 per cent wood alcohol in New York State. At the current value of 45 cents per gallon, this should be worth $856,830.15. This is based upon the total consumption of 192,330 cords per year in the industry and the average yield of 9.9 gallons of 82 per cent wood alcohol per cord.

It is further estimated that between 10 and 11 million gallons of wood alcohol are produced every year in this country. Its greatest single use is as a solvent. Probably 90 per cent of all the wood alcohol used is for this purpose in one way or another. Its greatest consumption is probably in the paint and varnish industry in which about 35 to 50 per cent is utilized.

Practically no wood alcohol is used in the raw 82 per cent state. It is all refined to a higher state of purity before being utilized. One concern refines a good share of the total product of the country.

Wood alcohol is used very largely in aniline dye factories to make colors, especially greens, purples and light blues. It is also used in the manufacture of formaldehyde, photographic films and in stiffening hats.

Refined wood alcohol of high purity or methyl alcohol, that is, of 99 to 100 per cent purity, is sold under a great variety of trade names, such as Columbian methanol, colonial methyl, diamond methyl, etc. As an extraction agent wood alcohol is used in the manufacture of smokeless powder, nitro cellulose and other explosives. Gun cotton for example is freed from cellulose nitrates by extraction with wood alcohol.

Other common uses are as follows: As fuel, as an illuminant, as a denaturant and in various chemical and medicinal preparations.

*Charcoal.*

The annual production of charcoal for 1916 in New York State is estimated to be 8,198,491 bushels. At a valuation of six cents per bushel this should be worth $491,991.46. This is estimated on the basis of the average production of 42.7 bushels of charcoal per cord from 192,330 cords of wood annually consumed in the industry in New York.

Up to about 1905 the great market for charcoal was in the reduction of iron ores. Important methods of steel production within recent years, however, have gradually eliminated the strong demand for charcoal for this particular purpose. Charcoal iron, or Swedish iron as it is often called in the trade, is still in demand for certain specialized uses, especially for high grade steel used for tools, instruments, car wheels, etc. Pig iron reduced with charcoal commonly brings $5 a ton more than coke iron. A single blast furnace uses between 10 and 12 thousand bushels of charcoal a day. Where there are from 5 to 10 blasting furnaces at a single ore reduction plant, it is easily seen that the consumption of charcoal may be very large. A great many of the hardwood distillation plants in Michigan and Wisconsin have ore reducing plants in connection with them. These are the conditions under which the greatest economy in charcoal utilization is practiced. Much of the charcoal for these plants, however, is made by the open pit or bee-hive kiln as well as by the oven plants. An investigation carried on by the United States Forest Service showed the consumption of charcoal in this country to be as follows: seventy-six per

Photograph by Nelson C. Brown.

Interior of the oven house of the Tupper Lake Chemical Co., Tupper Lake, N. Y., showing the outside doors of the ovens. In the immediate foreground is a turn-table from which the loaded wood cars are sent into the oven for distillation. The residual charcoal is withdrawn from the same door and sent into the first cooling ovens, which are on the right of the picture. The white spot in the left foreground indicates the opening through which the charcoal is fed into the furnaces beneath. For fuel, charcoal, wood gas and tar are used. On the right is a wood car containing charcoal which is shovelled directly into the furnaces. Twenty-five foot ovens which contain two cars at a charge, are used in this plant. There are seven ovens arranged in a row.

cent went to blast furnaces; 19.5 per cent was utilized in domestic uses; 1.9 per cent was used for chemical purposes; 1.03 per cent was used for power mills and the remainder went to smelters, railroads, etc. However, replies from only 60 per cent of the plants were received, so that it is not likely that a large number of plants throughout New York and Pennsylvania are properly represented by this estimate.

Charcoal is probably used in a greater variety of ways from the New York plants than from those in other states. There is no question but what the greatest majority of charcoal produced in this country is still used in blast furnaces and for the manufacture of gun powder.

One New York plant screens it and ships it in five different grades. When the charcoal is shipped it is screened to remove the finer pieces. This is ground up in some cases and pressed into briquettes and used for fuel. Other common uses for charcoal are for medicinal purposes, for poultry and cattle food, in chemical manufacture and for fuel in a great variety of ways.

*Wood Tar.*

Based upon the annual consumption of wood in this industry there are 4,808,250 gallons of wood tar produced in New York State every year. This figure is based upon the average production of 25 gallons of wood tar per cord. At the present time practically all of the wood tar is used for fuel under the ovens or boilers. Throughout the country it is estimated that between 30 and 40 million gallons of wood tar are used in this way. In some cases prices of between 4 and 8½ cents have been received per gallon for the use of this material in chemical manufactures, but its use is very limited. It is estimated that some time in the future a method will be found for using this wood tar as a basis of creosote on a commercial scale. A good share of our creosote at the present time is made from coal tar and a large part of it is imported. There is no question that some time in the future this material will be used for the preservation of wooden material, such as ties, poles, mine timber, etc.

*Wood Gas.*

It is estimated that about 11,500 cubic feet of gas are derived per cord of wood. On this basis there are produced annually in New York State 2,211,795,000 cubic feet of wood gas every year, from 192,330 cords.

This gas is used entirely as a fuel underneath the ovens at the present time. In some localities in Germany and Austria wood gas has been used for illuminating purposes, and it is very possible that at some time in the future this may be used for a much more economical purpose than as a fuel underneath the ovens. This, however, is looking a long way in advance and it is probable that for some time at least it will continue to serve the purpose of fuel along with the wood tar and coal or other fuel brought in to supply the necessary amount of heat.

Volume XVII May, 1917 Number 5

TECHNICAL PUBLICATION NO. 6

OF

THE NEW YORK STATE COLLEGE OF FORESTRY

AT

SYRACUSE UNIVERSITY

In Cooperation With the Forest Service
United States Department of Agriculture

# Wood Utilization Directory of New York

BY

JOHN HARRIS
Forest Service

Revised and Rearranged by

NELSON C. BROWN
Professor of Forest Utilization

AND

HENRY H. TRYON
Assistant Professor of Forest Utilization

Published Quarterly by the University
Syracuse, New York

Entered at the Postoffice at Syracuse as second-class mail matter

The new quarters of the New York State College of Forestry at Syracuse University. This has recently been completed and equipped at a total cost of about $300,000. The Eastern Forest Products Laboratory is housed in14,000 square feet of space in the basement of this building. This will be of great assistance to the Wood Utilization Service of the college which for the past five years has been actively engaged in saving material formerly wasted in our wood-using industries as well as in our sawmills and in the woods.

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SYRACUSE UNIVERSITY

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## TECHNICAL PUBLICATIONS

OF

## THE NEW YORK STATE COLLEGE OF FORESTRY

1. Preliminary Report on Diseases of Fish in the Adirondacks, by Dr. W. M. Smallwood. 1914.

2. I. A New Species of Pityogenes, by J. M. Swaine.
   II. Observations on the Life History and Habits of Pityogenes Hopkinsi, Swaine, by M. W. Blackman, Ph. D., pp. 11–66, with six plates. 1916.

3. The Development of the Vegetation of New York State, by Dr. William L. Bray. 1916.

4. The Relation of Mollusks to Fish in Oneida Lake, by Frank Collins Baker. 1916.

5. The Hardwood Distillation Industry in New York, by Nelson C. Brown. 1917.

6. Wood Utilization Directory of New York, by John T. Harris, Forest Service, revised and rearranged by Nelson C. Brown and Henry H. Tryon. 1917.

7. The Relation of Birds to the Western Adirondack Forest, by P. M. Silloway. 1917.

8. The Black Zones Formed by Wood-Destroying Fungi, by Arthur S. Rhoads. 1917.

## TABLE OF CONTENTS.

## ACKNOWLEDGMENT

This bulletin is based upon data and information compiled by The New York State College of Forestry at Syracuse University in co-operation with the Forest Service of the United States Department of Agriculture at Washington, D. C. The data were published in the volume entitled "Wood Using Industries of New York," by John T. Harris, as No. 2 of Series 14 of the regular publications of The New York State College of Forestry. The work was done under the direction of Dr. Hugh P. Baker, Dean of the College of Forestry, and O. T. Swan, in charge of industrial investigations, United States Forest Service.

Ever since this publication was issued in 1913, the need has been felt for a smaller, condensed volume, re-arranged in such shape that the ordinary producer and consumer of forest products of New York could make use of it to better advantage. The New York State College of Forestry does not claim any originality in a large part of the material for this bulletin, but its rearrangement, corrections, and added data as the results of its investigations over the State during the past three years are based entirely upon the work of the Department of Forest Utilization in the State College of Forestry at Syracuse. The original data were compiled as a result of personal investigation carried on by Mr. John T. Harris of the United States Forest Service, Professor Nelson C. Brown and Professor Edward F. McCarthy of The New York State College of Forestry at Syracuse.

During the past three years considerable data have been compiled, many corrections have been entered, much of the original text has been omitted, and in its place has been inserted material descriptive of the particular work being done by the Department of Forest Utilization of The New York State College of Forestry.

# WOOD UTILIZATION DIRECTORY OF NEW YORK

## Purpose of Bulletin

This bulletin is intended to be a hand-book or Directory of Wood Utilization in New York State. It is intended to be used as a manual in bringing together to mutual advantage the producer and consumer of forest products. It contains chiefly the following information.

1. The amount of wood consumed of each species used in New York.
2. The average price per thousand board feet paid for these species delivered at the mill or wherever the wood is used.
3. The source of this material — that is, whether produced in New York State or imported from other states or Canada.
4. The amount of each kind of wood used in each industry in New York State and the average price for each kind of wood used in each industry.

The Directory is divided up into four main parts as follows:

Part I. *Summary of woods used and total amount of lumber consumed in each industry.*

There are two long tables in this part; one shows the amount of each kind of wood used together with the average prices paid in the State and is to be found on pages 22 to 24; the other shows the amount and cost of lumber consumed in the different wood using industries of the State and is found on pages 25 and 26.

Part II. *Tables showing the use of woods in each industry.*

This part is made up of a series of tables showing the amount of each kind of wood used in the various wood using industries and the average prices paid, such for example as for boxes and crates, furniture, musical instruments, etc. There are forty-seven tables in this part, representing a like number of industries, and these tables are to be found on pages 28 to 51.

Part III. *Tables showing how each species is used.*

Herein is included a series of tables showing the amount of each kind of wood used in the State, in what industry it is used and the average price paid for the use of this wood in each industry. There are fifty-three tables representing fifty-three species in this part and it is found on pages 54 to 91.

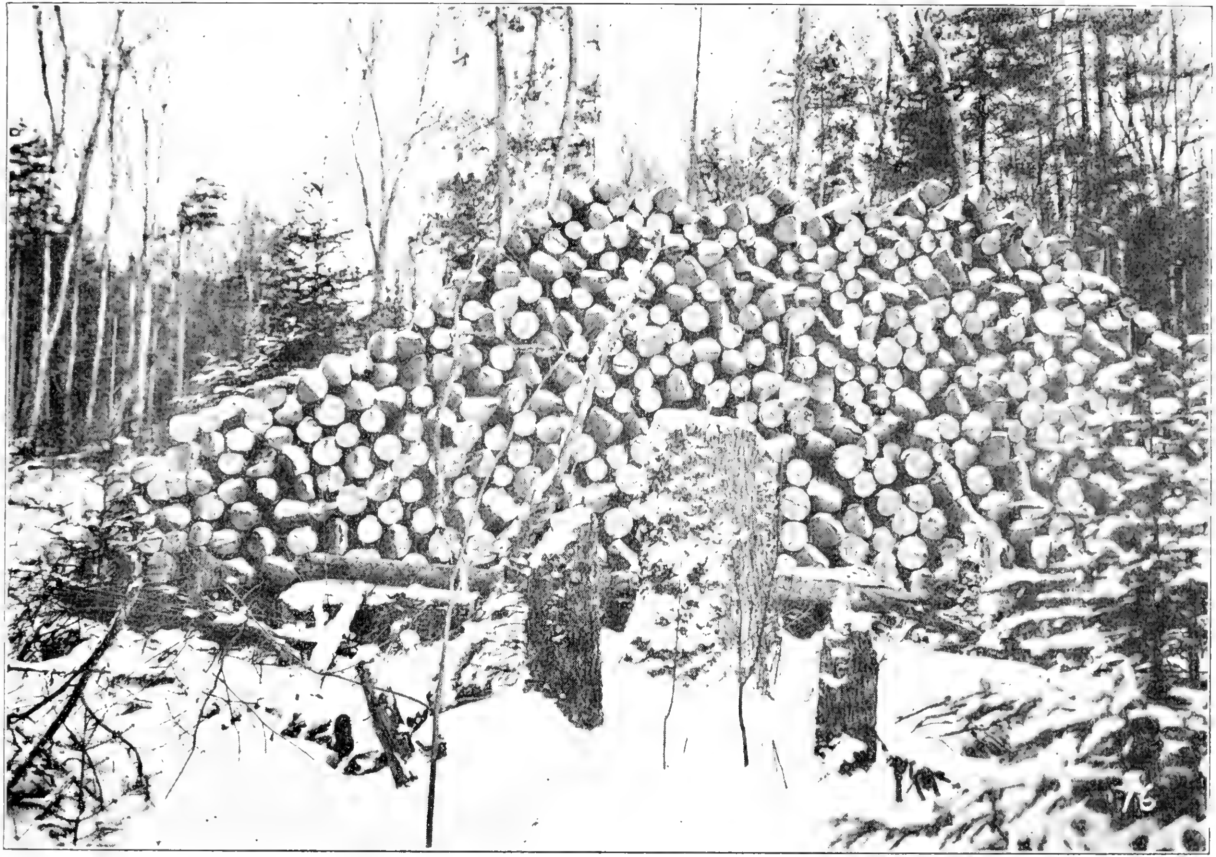
Part IV. *Directory of manufacturers.*

This is a Directory of the Wood Using Industries of New York State arranged alphabetically by counties and by industries in each town. That is, under Albany county, for example, the towns are arranged alphabetically and the industries are classified alphabetically in each town.

By carefully studying the different tables and the information contained in them, it is believed that much information of value can be obtained by owners of timberland wishing to sell their mature timber, by the various wood-using industries desiring a market for their waste, by factories requiring raw materials for small wooden articles and by the general public interested in wood utilization, the amount and kinds of wood used in the State, average prices paid, etc. The directory is found on pages 95 to 204.

## Principal Facts Brought Out by the Wood-using Industries Report

1. New York State is the greatest consumer of forest products among all the states of the Union. It uses annually over 1,750,000,000 board feet of lumber in its wood-using industries, besides about 1,000,000 cords of wood for pulp,



Skidway of spruce pulp logs in the Adirondacks. New York uses over 1,000,000 cords of pulpwood every year and there is a steadily increasing demand for not only spruce, the principal wood used for paper, but for balsam fir, popple, hemlock and others. Spruce pulpwood is now bringing from $12 to $16 per cord and more, depending on its location, peeled condition and general quality.

over 130,000 cords for wood distillation, and vast quantities of rough lumber, railroad ties, poles, posts, cooperage and tannin stock, fuelwood, etc.

2. The annual lumber bill alone of the State is over $60,000,000. A good share of this (about two-thirds) goes out of the State. New York should produce, within its own borders, all the lumber and wood it requires.

3. About one-fourth of all our lumber used in the State is white pine. Spruce is next, with nearly ten per cent. of the total consumption; then white oak with over seven per cent., and then southern yellow pine. Vast quantities of southern and western timbers are shipped into the State every year. New York should produce more of the lumber and other products of the forest that are used annually.

4. The average prices paid at the mill or factory for the principal woods growing in the State are as follows (price based on rough lumber delivered, per thousand board feet):

| | |
|---|---|
| White oak | $46 25 |
| Cherry | 46 22 |
| Hickory | 43 03 |
| Yellow poplar | 40 47 |
| Red oak | 38 49 |
| Ash | 38 49 |
| Birch | 30 07 |
| Chestnut | 28 56 |
| Elm | 28 37 |
| White pine | 27 70 |
| Basswood | 27 36 |
| Sugar maple | 27 07 |
| Spruce | 21 31 |
| Beech | 20 54 |
| Hemlock | 19 82 |

## New York State in the Lumber Industry

New York for a long time was the great leader in lumber production in this country. After the earliest colonial times, Maine was the center of lumber production but it rapidly moved over to New York State and for about one hundred years, up to 1850, New York was the center of the lumber industry. In 1860 it was second among all the states in the lumber industry; in 1870, third; and it has gradually been losing in importance until at the present time it is twenty-third in the list of all states in order of lumber production. For a long time Albany was the center of lumber distribution in the country. Buffalo is now a very important center, especially for woods brought into the State.

However, in the future, New York is destined to be a very important lumber state. Over one-half of the State is better suited to forest crops than any other crop from the soil. It has admirable soil and climatic conditions for the growth of timber. A great variety of species can be grown to advantage within the State, and the splendid transportation facilities and markets for all classes of forest products tend to make New York a great forest state in the future. At the present time over one million people are directly or indirectly dependent upon the lumber and wood-using industries in the State, and in addition a considerable amount of capital is invested in them.

The following figures have been compiled by the Conservation Commission:

## Forest Products of New York for 1913

| Species. | Lumber, Feet b. m. | Pulpwood, cords. | Number of mills reporting. |
|---|---|---|---|
| Spruce | 52,061,700 | 354,793 | 372 |
| Hemlock | 128,440,828 | 67,439 | 1,635 |
| Maple | 78,103,985 | ........ | 1,338 |
| Pine | 78,271,480 | 217 | 1,209 |
| Birch | 31,906,350 | ........ | 672 |
| Beech | 41,478,550 | ........ | 904 |
| Basswood | 29,703,865 | 5,475 | 1,284 |
| Oak | 25,799,050 | ........ | 953 |
| Chestnut | 18,139,275 | ........ | 783 |
| Elm | 14,766,535 | ........ | 884 |
| Ash | 11,130,065 | ........ | 888 |
| Poplar | 1,567,910 | 39,941 | 216 |
| Hickory | 1,386,180 | ........ | 277 |
| Cherry | 3,588,555 | ........ | 441 |
| Balsam | 237,100 | 40,815 | 7 |
| Gum | 179,650 | ........ | 2 |
| Cucumber | 124,800 | ........ | 12 |
| Butternut | 121,785 | ........ | 32 |
| Cedar | 77,950 | ........ | 10 |
| Willow | 57,984 | ........ | 8 |
| Locust | 30,700 | ........ | 9 |
| Tamarack | 20,000 | ........ | 5 |
| Black walnut | 9,525 | ........ | 8 |
| Sycamore | 2,050 | ........ | 1 |
| Total | 517,205,872 | 508,680 | ........ |

*Miscellaneous Materials.*

| | | |
|---|---|---|
| Roundwood for alcohol, excelsior, cooperage, kilns, etc. | 266,073 | cords |
| Shingles | 27,919,250 | pieces |
| Lath | 28,187,850 | pieces |
| Heading | 15,522,832 | pieces |
| Staves | 56,809,770 | pieces |
| Railroad ties | 839,670 | pieces |
| Posts | 178,585 | pieces |
| Poles | 70,088 | pieces |

*Summary.*

| | | |
|---|---|---|
| Lumber | 517,205,872 | ft., b. m. |
| Pulpwood (cords equivalent to) | 279,265,320 | ft., b. m. |
| Roundwood (cords equivalent to) | 146,074,077 | ft., b. m. |
| Grand total | 942,545,269 | ft., b. m. |

Of the 34,000,000 acres in the State, 22,000,000 are included in farms, and of this only 15,000,000 are actually in crops. This means that 7,000,000 acres of farms are idle; and it is estimated that less than half of the 12,000,000 outside of farms contains merchantable timber. To obtain the most use from all land whatsoever, it is reliably estimated that beween 12,000,000 and 14,000,000 acres in the State must eventually be devoted entirely to forests. Such an area is greater than that of Massachusetts, Connecticut and Rhode Island combined, and is equal to all that part of New York north of the New York Central line.

## WOOD UTILIZATION SERVICE OF THE NEW YORK STATE COLLEGE OF FORESTRY AT SYRACUSE

For the past three years the Department of Forest Utilization of The New York State College of Forestry has carried on, by corespondence, a wood utilization service intended primarily to obtain a profitable market for woods and mill waste otherwise sold for fuel or wasted in one way or another.

When it is realized that only forty per cent. of the trees actually felled in our woods is ultimately utilized, it can be readily seen that one of the greatest problems of forest conservation is a closer utilization of our raw wood supplies.

This wood utilization service has met with a great deal of interest in various parts of the State, and the College of Forestry has issued bulletins from time to time, giving the needs of both the producers and consumers of various forest products, wood waste, etc., which has resulted in a considerable saving of raw wood supplies, as well as resulting in mutual benefit and advantage to both the producer and consumer.

The State College of Forestry is glad to extend this service to anyone desiring it. It is glad either to list any wood-using industries in this service to receive these bulletins, or to enter in one of these periodical bulletins the particular wishes or needs of any producer or consumer of forest products in

New York State. There are now about 500 of the principal manufacturers of small wooden articles, crating and box board stock, novelties, toys and miscellaneous articles of wood which receive the wood utilization service bulletins periodically.

## EASTERN FOREST PRODUCTS LABORATORY

The New York State College of Forestry at Syracuse University has established a Forest Products Laboratory which will be located in the large, commodious basement of the new $250,000 building recently granted by the State Legislature. Over 12,000 square feet of space will be available for this laboratory.

It is believed that this laboratory will be of distinct service and usefulness in helping to solve some of the many problems of wood utilization in New York. There will be a wood-testing laboratory, a paper and pulp laboratory, special facilities will be offered to carry on experiments in wood preservation, strength and bending tests, durability of various woods, seasoning, etc.

The American Saw Mill Machinery Company of Hackettstown, N. J., has donated a complete and modern portable sawmill which will be of much value in helping to solve some of these laboratory experiments and problems. Correspondence regarding the use of this laboratory and experiments to be carried out will be gladly welcomed by the College.

## HOW TO USE THIS REPORT

The chief value of this report lies in the information showing how all the various woods are used in New York State and the average prices that are being paid for these woods in the various wood-using industries of the State.

A typical example of how this report may be used to advantage may be illustrated as follows: A woodlot owner in Chautauqua county has some large hard maple for sale, and is anxious to get the best price for it. In the table showing the use of hard maple in New York State he finds that it is principally used for boot and shoe findings, planing

A good instance of close utilization. The owner of this woodlot cut his poplar into four-foot bolts and sold them profitably to an excelsior mill. The limbs and "trash" wood were sold locally for fuel.

This operation not only netted a comfortable profit, but served to better the silviculture condition of the stand. The removal of the mature (and in many cases decaying) poplar liberated the pine and hemlock, permitting them to make much faster growth.

Photograph by HENRY H. TRYON.

mill products, musical instruments, furniture and agricultural implements. He also learns from this same table on page 58, that the average prices of $24.15, $25.28, $35.28, $28.62, and $28.84 per thousand board feet respectively are paid for this species in each of these industries. Next he looks up the various wood-using industries in Chautauqua county and finds listed alphabetically the various industries which the table indicates pay the best prices for his hard maple. He corresponds with these various parties and obtains the best prices. If sufficient users of the various woods are not obtainable in the local county, it is suggested that full correspondence be directed to firms in neighboring counties so that one can get the broadest available market for his product.

In case the owner of forest products is not successful in his search by mail, it is suggested that he take the matter up directly with the Department of Forest Utilization of The New York State College of Forestry.

Another example is shown as follows. A woodlot owner in Putnam county finds that his chestnut is rapidly dying off, due to the chestnut bark disease. He finds, on looking up the chestnut table on page 60, that this wood is chiefly used for dairymen's, poulterers' and apiarists' supplies, sash doors and blinds, furniture, caskets and coffins, planing mill products and boxes and crating, and that average prices of $31.66, $36.17, $23.00, $24.12, $31.07 and $17.40 are paid respectively in these industries. He refers to the directory of wood-using industries, beginning on page 95, and finds the names and addresses of concerns with whom to correspond. If his chestnut is large, sound and of good quality, and situated near a railroad or haul-road he may expect good average prices. Through correspondence, the owner may get better prices by having it sawed to order by a portable mill or by delivering it in the log.

If a wood-using factory has considerable waste of a given species, a profitable market may be secured by looking up in this report the names of companies manufacturing toys, brush backs, novelties, spools or any of the many small wooden articles for which this particular wood may be used.

Considerable saving has already resulted from the use of wood formerly wasted for toys, buttons, furniture parts, wood buttons, skewers, spools, novelties, souvenirs, small handles, small box material, chair stock, dowels, vehicle parts, etc.

## Proposed Publications

This bulletin is intended to be a statistical and tabular statement of wood utilization conditions in New York. If full explanation and description of the commercial and technical questions involved were added it would require a bulletin of too large and bulky proportions.

It is planned, therefore, to issue from time to time separate bulletins covering the principal features of the so-called minor forest industries and wood utilization conditions in New York. This College of Forestry has been conducting investigative and research work in several of these industries during the past three years.

These bulletins as far as funds are available will be issued from time to time on the following:

(1) The wood distillation industry in New York.
(2) The cooperage industry in New York.
(3) The production and use of railroad ties in New York.
(4) The production and use of telephone poles in New York.
(5) The production, use and preservative treatment of fence posts and grape stakes in New York.
(6) Possibilities of the portable sawmill and its relation to forestry in New York.
(7) The maple sugar and syrup industry in New York.
(8) The cutting, marketing and use of hemlock bark and other tannin products in New York.
(9) The cutting, marketing and use of fuelwood in New York.
(10) The cutting and marketing of the principal woodlot products in New York.
(11) The box board industry in New York.
(12) The furniture industry in New York.
(13) The manufacture and use of veneers in New York.
(14) The wood pulp industry in New York.

Studies of the utilization of individual species have also been in progress as well as county utilization studies.

# PART I

## Summary of Woods Used and Total Amount of Lumber Consumed in Each Industry

TABLE 1 — SUMMARY OF KINDS OF WOOD USED IN NEW YORK

| Kind of Wood | | Quantity Used Annually | | Average cost per 1,000 ft. | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|---|
| Common name | Botanical name | Feet b. m. | Per cent | | | | |
| White pine | *Pinus strobus* | 422,686,634 | 24.09 | $27 70 | $11,706,362 | 158,109,000 | 264,577,634 |
| Spruce | *Picea* species | 169,107,607 | 9.64 | 21 31 | 3,603,522 | 76,162,900 | 92,944,707 |
| White oak | *Quercus alba* | 130,421,577 | 7.43 | 46 25 | 6,031,850 | 30,335,677 | 100,085,900 |
| Shortleaf pine | *Pinus echinata* | 130,134,500 | 7.42 | 27.29 | 3,550,880 | .......... | 130,134,500 |
| Sugar maple | *Acer saccharum* | 90,194,650 | 5.14 | 27 07 | 2,441,644 | 56,905,700 | 33,288,950 |
| Hemlock | *Tsuga canadensis* | 83,028,900 | 4.73 | 19 82 | 1,645,523 | 49,080,400 | 33,948,500 |
| Chestnut | *Castenea dentata* | 71,054,190 | 4.05 | 28 56 | 2,029,271 | 13,627,550 | 57,426,640 |
| Loblolly pine | *Pinus taeda* | 70,596,671 | 4.02 | 20 77 | 1,466,092 | .......... | 70,596,671 |
| Longleaf pine | *Pinus palustris* | 64,368,715 | 3.67 | 32 41 | 2,086,128 | .......... | 64,368,715 |
| Cypress (bald) | *Taxodium distichum* | 60,314,370 | 3.44 | 39 97 | 2,410,846 | .......... | 60,314,370 |
| Red oak | *Quercus rubra* | 59,868,300 | 3.41 | 38 49 | 2,304,056 | 17,282,050 | 42,586,250 |
| Yellow poplar | *Liriodendron tulipifera* | 57,016,880 | 3.25 | 40 47 | 2,307,576 | 5,250,900 | 51,765,980 |
| Basswood | *Tilia americana* | 56,977,220 | 3.25 | 27 36 | 1,558,801 | 32,621,350 | 24,355,870 |
| Birch | *Betula* species | 44,136,326 | 2.52 | 30 07 | 1,327,269 | 30,508,032 | 13,628,294 |
| Beech | *Fagus atropunicea* | 42,546,814 | 2.43 | 20 54 | 873,815 | 31,492,600 | 11,054,214 |
| Red gum | *Liquidambar styraciflua* | 41,940,175 | 2.39 | 29 16 | 1,222,838 | 75,000 | 41,865,175 |
| Cottonwood | *Populus deltoides* | 22,778,000 | 1.30 | 21 00 | 478,345 | 14,508,000 | 8,270,000 |
| Ash | *Fraxinus* species | 17,556,225 | 1.00 | 38 49 | 675,777 | 8,369,225 | 9,187,000 |
| Elm | *Ulmus* species | 17,310,500 | .99 | 28 37 | 491,076 | 8,300,600 | 9,009,900 |
| Red cedar | *Juniperus virginiana* | 16,766,575 | .96 | 37 98 | 636,774 | 2,500 | 16,764,075 |
| Norway pine | *Pinus resinosa* | 12,420,300 | .71 | 22 99 | 285,489 | 140,000 | 12,280,300 |
| Mahogany | *Swietenia mahogoni* | 11,208,720 | .64 | 138 84 | 1,556,272 | .......... | 11,208,720 |
| Silver maple | *Acer saccharinum* | 8,960,650 | .51 | 25 71 | 230,379 | 4,587,400 | 4,373,250 |
| Hickory | *Hicoria* species | 8,755,100 | .50 | 43 03 | 376,702 | 2,551,150 | 6,203,950 |
| Spanish cedar | *Cedrela odorata* | 8,582,500 | .49 | 113 11 | 970 798 | .......... | 8,582,500 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pitch pine | *Pinus rigida* | 6,023,600 | .34 | 19 67 | 118,510 | 2,231,600 | 3,792,000 |
| Western white pine | *Pinus monticola* | 3,935,000 | .23 | 40 65 | 159,966 | .......... | 3,935,000 |
| Cherry (black) | *Prunus serotina* | 3,242,750 | .19 | 46 22 | 149,883 | 748,050 | 2,494,700 |
| Balm of Gilead | *Populus balsamifera* | 3,086,850 | .18 | 19 89 | 61,411 | 3,000,000 | 86,850 |
| Black walnut | *Juglans nigra* | 2,629,128 | .15 | 117 15 | 308,014 | 570,675 | 2,058,453 |
| Tamarack | *Larix laricina* | 2,077,000 | .12 | 18 05 | 37,480 | 27,000 | 2,050,000 |
| Sugar pine | *Pinus lambertiana* | 1,647,100 | .09 | 46 83 | 77,140 | .......... | 1,647,100 |
| Arborvitae (northern white cedar) | *Thuja occidentalis* | 1,623,600 | .09 | 24 61 | 39,949 | 929,700 | 693,900 |
| Douglas fir | *Pseudotsuga taxifolia* | 1,508,600 | .09 | 50 95 | 76,866 | .......... | 1,508,600 |
| Cotton gum | *Nyssa aquatica* | 1,388,616 | .08 | 42 41 | 58,891 | .......... | 1,388,616 |
| Western red cedar | *Thuja plicata* | 1,245,200 | .07 | 30 85 | 38,415 | .......... | 1,245,200. |
| Balsam fir | *Abies balsamea* | 883,800 | .05 | 28 97 | 25,605 | 358,800 | 525,000 |
| Western yellow pine | *Pinus ponderosa* | 875,000 | .05 | 37 31 | 32,650 | .......... | 875,000 |
| Redwood | *Sequoia sempervirens* | 767,700 | .04 | 41 74 | 32,041 | .......... | 767,700 |
| Butternut | *Juglans cinerea* | 765,700 | .04 | 37 63 | 28,813 | 166,900 | 598,800 |
| Lignum-vitae | *Guaiacum officinale* | 663,500 | .04 | 130 26 | 86,425 | .......... | 663,500 |
| Circassian walnut | *Juglans regia* | 622,100 | .04 | 267 22 | 166,237 | .......... | 622,100 |
| Western larch | *Larix occidentalis* | 450,275 | .03 | 32 51 | 14,637 | .......... | 450,275 |
| Aspen | *Populus tremuloides* | 362,200 | .02 | 17 77 | 6,436 | 56,200 | 306,000 |
| Cucumber | *Magnolia acuminata* | 292,500 | .02 | 29 42 | 8,605 | 153,000 | 139,500 |
| Ebony | *Diospyros* species | 254,654 | .02 | 122 78 | 31,266 | .......... | 254,654 |
| Southern white cedar | *Chamaecyparis thyoides* | 230,000 | .01 | 58 06 | 13,354 | .......... | 230,000 |
| Black gum | *Nyssa sylvatica* | 210,000 | .01 | 18 29 | 3,840 | .......... | 210,000 |
| Teak | *Tectona grandis* | 190,800 | .01 | 262 42 | 50,070 | .......... | 190,800 |
| Sycamore | *Platanus occidentalis* | 182,712 | .01 | 37 06 | 6,772 | 2,700 | 180,012 |
| Locust | *Robinia pseudacacia* | 147,528 | * | 57 92 | 8,545 | 63,900 | 83,628 |
| Persimmon | *Diospyros virginiana* | 94,000 | * | 98 60 | 9,268 | .......... | 94,000 |
| Rosewood | *Dalbergia* species | 63,710 | * | 219 89 | 14,009 | .......... | 63,710 |
| Buckeye | *Aesculus* species | 61,400 | * | 25 98 | 1,595 | 2,000 | 59,400 |
| Witch hazel | *Hamamelis virginiana* | 56,500 | * | 35 88 | 2,027 | .......... | 56,500 |
| Satinwood | *Chloroxylon swietenia* | 51,450 | * | 254 77 | 13,108 | .......... | 51,450 |
| English oak | *Quercus* species | 36,380 | * | 341 34 | 12,418 | .......... | 36,380 |
| Sitka spruce | *Picea sitchensis* | 27,000 | * | 49 07 | 1,325 | .......... | 27,000 |
| Boxwood | *Tabebuia pentaphylla* | 25,000 | * | 100 00 | 2,500 | .......... | 25,000 |
| Applewood | *Pyrus* species | 23,000 | * | 66 39 | 1,527 | 1,000 | 22,000 |

TABLE 1 — SUMMARY OF KINDS OF WOOD USED IN NEW YORK — *Concluded*

| KIND OF WOOD | | QUANTITY USED ANNUALLY | | Average cost per 1,000 ft. | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|---|
| Common name | Botanical name | Feet b. m. | Per cent | | | | |
| Balsawood (corkwood) | *Ochroma lagopus* | 20,000 | * | 40 00 | 800 | ........ | 20,000 |
| Willow | *Salix* species | 16,100 | * | 14 60 | 235 | 13,100 | 3,000 |
| Vermilion | *Pterocarpus indicus* | 3,000 | * | 300 00 | 900 | ........ | 3,000 |
| Sassafras | *Sassafras sassafras* | 1,500 | * | 21 34 | 32 | 1,500 | ........ |
| Holly (American) | *Ilex opaca* | 1,000 | * | 100 00 | 100 | ........ | 1,000 |
| Granadillo (cocowood) | *Brya ebenus* | 685 | * | 113 87 | 78 | ........ | 685 |
| Cocobola | *Platymiscium* species | 480 | * | 160 42 | 77 | ........ | 480 |
| Total | ........ | 1,754,486,217 | * | ........ | ........ | 548,236,159 | 1,206,283,058 |

* Less than 1-100 of 1 per cent.

The following woods were purchased by pound or by piece:.

| | | | |
|---|---|---|---|
| Bamboo | Haw | Orange | Rattan |
| Congo | Hornbeam | Partridge | Scotch thistle |
| Corra | Lancewood | Pea | Weitzel |
| Furze | Malacca | Peach | Whangee |

TABLE 2 — SUMMARY OF WOODS USED BY INDUSTRIES IN NEW YORK

| INDUSTRY | Quantity Used Annually | | Average cost per 1,000 ft. | Total cost f. o. b. factory. | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Planing mill products | 388,191,660 | 22.13 | $27 30 | $10,596,797 | 182,840,050 | 205,351,610 |
| Boxes and crates, packing | 370,550,400 | 21.12 | 21 73 | 8,051,943 | 66,800,650 | 303,749,750 |
| Sash, doors, blinds and general mill work | 341,277,662 | 19.45 | 33 87 | 11,560,203 | 94,256,900 | 247,020,762 |
| Furniture | 104,452,092 | 5.95 | 41 04 | 4,286,194 | 32,717,532 | 71,734,560 |
| Car construction | 76,201,900 | 4.34 | 28 32 | 2,157,905 | 3,103,700 | 73,098,200 |
| Instruments, musical | 58,816,550 | 3.35 | 45 97 | 2,703,698 | 21,081,800 | 37,734,750 |
| Dairymen's, poulterers' and apiarists' supplies | 39,015,000 | 2.23 | 28 05 | 1,095,317 | 9,666,100 | 29,378,900 |
| Ship and boat building | 37,700,500 | 2.15 | 41 19 | 1,553,008 | 5,195,000 | 32,505,500 |
| Vehicles and vehicle parts | 30,633,100 | 1.75 | 43 95 | 1,346,380 | 11,122,300 | 19,510,800 |
| Agricultural implements | 28,055,600 | 1.60 | 31 29 | 877,920 | 9,444,200 | 18,611,400 |
| Boot and shoe findings | 22,882,000 | 1.30 | 25 04 | 572,963 | 19,541,000 | 3,341,000 |
| Chairs | 21,612,200 | 1.23 | 38 43 | 830,663 | 11,997,300 | 9,614,900 |
| Fixtures | 20,175,615 | 1.15 | 49 37 | 996,087 | 5,748,950 | 14,426,665 |
| Instruments, professional and scientific | 19,811,800 | 1.13 | 37 91 | 751,045 | 1,726,500 | 18,085,300 |
| Caskets and coffins | 18,161,000 | 1.04 | 33 13 | 601,703 | 621,000 | 17,540,000 |
| Baskets and fruit packages | 18,007,250 | 1.03 | 18 51 | 333,265 | 14,145,250 | 3,862,000 |
| Excelsior | 14,697,000 | .84 | 16 87 | 247,990 | 13,772,000 | 925,000 |
| Refrigerators and kitchen cabinets | 12,268,700 | .70 | 32 14 | 394,316 | 3,602,200 | 8,666,500 |
| Tanks and silos | 11,332,950 | .65 | 30 03 | 340,372 | 1,470,300 | 9,862,650 |
| Cigar boxes | 10,115,550 | .58 | 104 04 | 1,052,412 | .......... | 10,115,550 |
| Pumps | 9,804,800 | .56 | 28 93 | 283,625 | 1,507,300 | 8,297,500 |
| Woodenware and novelties | 8,364,900 | .48 | 29 94 | 250,448 | 5,681,400 | 2,683,500 |
| Frames and moulding, picture | 7,514,450 | .43 | 44 74 | 336,229 | 1,968,900 | 5,545,550 |
| Handles | 6,474,979 | .37 | 20 52 | 132,880 | 5,907,900 | 567,079 |
| Laundry appliances | 5,201,340 | .30 | 30 46 | 158,414 | 1,655,500 | 3,545,840 |

TABLE 2 — SUMMARY OF WOODS USED BY INDUSTRIES IN NEW YORK — *Concluded*

| INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 ft. | Total cost f. o. b. factory. | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Machinery and apparatus, electrical | 4,602,860 | .26 | 29 10 | 133,964 | 2,305,000 | 2,297,860 |
| Machine construction | 4,555,900 | .26 | 34 37 | 156,568 | 2,884,000 | 1,671,900 |
| Sporting and athletic goods | 4,230,100 | .24 | 61 04 | 258,203 | 1,403,400 | 2,826,700 |
| Trunks and valises | 3,536,000 | .20 | 33 21 | 117,425 | 1,211,000 | 2,325,000 |
| Patterns and flasks | 3,388,300 | .19 | 49 43 | 167,499 | 1,005,600 | 2,382,700 |
| Toys | 2,994,500 | .17 | 27 36 | 81,932 | 1,961,500 | 1,033,000 |
| Clocks | 2,948,159 | .17 | 31 93 | 94,139 | 171,227 | 2,776,932 |
| Elevators | 2,663,200 | .15 | 31 06 | 82,723 | 698,000 | 1,965,200 |
| Whips, canes, umbrella sticks | 2,237,000 | .13 | 28 33 | 63,375 | 2,000,000 | 237,000 |
| Plumbers' woodwork | 1,787,000 | .10 | 37 34 | 66,730 | 870,000 | 917,000 |
| Printing material | 1,737,500 | .10 | 37 76 | 65,615 | 612,500 | 1,125,000 |
| Rollers (shade and map) | 1,622,500 | .09 | 35 88 | 58,200 | 247,500 | 1,375,000 |
| Brushes and brooms | 1,562,500 | .09 | 24 40 | 38,130 | 1,172,200 | 390,300 |
| Shuttles, spools and bobbins | 962,000 | .05 | 21 02 | 20,225 | 742,000 | 220,000 |
| Pulleys and conveyors | 823,000 | .05 | 46 45 | 38,227 | 335,000 | 488,000 |
| Dowels | 753,000 | .04 | 34 38 | 25,891 | 703,000 | 50,000 |
| Gates and fencing | 725,500 | .04 | 26 83 | 19,462 | 160,500 | 565,000 |
| Signs and supplies | 599,500 | .03 | 28 11 | 16,853 | 36,500 | 563,000 |
| Firearms | 370,000 | .02 | 68 65 | 25,400 | .......... | 370,000 |
| Equipment, playground | 250,000 | .01 | 36 28 | 9,070 | 157,000 | 93,000 |
| Aeroplanes | 31,400 | * | 30 83 | 968 | 17,200 | 14,200 |
| Miscellaneous | 30,790,300 | 1.75 | 29 80 | 917,529 | 3,969,300 | 26,821,000 |
| Total | 1,754,519,217 | ........ | ........ | .......... | 548,236,159 | 1,206,283,058 |

* Less than 1–100 of 1 per cent.

# PART II

## Tables Showing the Use of Woods in Each Industry

TABLE 3 — PLANING MILL PRODUCTS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| White pine........ | 121,512,700 | 31.30 | $28 05 | $3,408,198 | 69,044,900 | 52,467,800 |
| Spruce........... | 75,416,560 | 19.43 | 20 27 | 1,528,850 | 37,818,800 | 37,597,760 |
| Hemlock.......... | 39,437,500 | 10.16 | 19 73 | 778,127 | 29,547,500 | 9,890,000 |
| Shortleaf pine...... | 29,106,200 | 7.50 | 29 17 | 849,081 | ........... | 29,106,200 |
| Cypress, bald...... | 17,199,250 | 4.43 | 45 15 | 776,566 | ........... | 17,199,250 |
| White oak........ | 15,337,100 | 3.95 | 41 09 | 630,130 | 5,926,100 | 9,411,000 |
| Sugar maple....... | 14,929,500 | 3.84 | 25 28 | 377,399 | 10,900,300 | 4,029,200 |
| Longleaf pine...... | 14,546,600 | 3.75 | 30 86 | 448,840 | ........... | 14,546,600 |
| Beech............ | 8,757,400 | 2.25 | 20 24 | 177,217 | 7,602,400 | 1,155,000 |
| Red oak.......... | 7,677,100 | 1.98 | 36 03 | 276,622 | 4,180,600 | 3,496,500 |
| Basswood......... | 7,569,900 | 1.95 | 25 29 | 191,408 | 5,057,400 | 2,512,500 |
| Birch............ | 7,382,100 | 1.90 | 27 36 | 201,940 | 5,021,500 | 2,360,600 |
| Chestnut.......... | 6,170,200 | 1.59 | 31 07 | 191,721 | 3,685,000 | 2,485,200 |
| Yellow poplar...... | 5,110,500 | 1.32 | 39 94 | 204,111 | 172,500 | 4,938,000 |
| Loblolly pine...... | 3,692,000 | .95 | 29 27 | 108,077 | ........... | 3,692,000 |
| Other species...... | 14,347,050 | ........ | ........ | .......... | ........... | .......... |
| Totals....... | 388,191,660 | ........ | ........ | .......... | 178,957,000 | 194,887,610 |

TABLE 4 — BOXES AND CRATES, PACKING

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| White pine........ | 132,945,200 | 35.88 | $20 89 | $2,776,575 | 24,747,700 | 108,197,500 |
| Loblolly pine...... | 57,845,000 | 15.61 | 19 95 | 1,154,216 | ........... | 57,845,000 |
| Spruce........... | 48,361,900 | 13.05 | 19 85 | 960,126 | 15,477,400 | 32,884,500 |
| Shortleaf pine...... | 47,060,000 | 12.70 | 24 32 | 1,144,654 | ........... | 47,060,000 |
| Hemlock.......... | 10,448,900 | 2.82 | 19 51 | 203,859 | 5,427,400 | 5,021,500 |
| Basswood......... | 10,289,900 | 2.78 | 25 65 | 263,929 | 4,369,000 | 5,920,900 |
| Yellow poplar...... | 9,543,400 | 2.58 | 24 72 | 235,819 | 88,500 | 9,454,900 |
| Cottonwood....... | 9,301,000 | 2.51 | 26 82 | 249,450 | 2,395,000 | 6,906,000 |
| Beech............ | 7,367,500 | 1.99 | 22 23 | 163,743 | 3,735,000 | 3,632,500 |
| Elm............. | 6,862,500 | 1.85 | 33 62 | 230,718 | 1,354,000 | 5,508,500 |
| Cypress (bald).... | 5,524,900 | 1.49 | 37 75 | 208,563 | ........... | 5,524,900 |
| Chestnut.......... | 4,380,250 | 1.18 | 17 40 | 76,218 | 1,612,750 | 2,767,500 |
| Other species...... | 20,537,950 | ........ | ........ | .......... | ........... | .......... |
| Totals....... | 370,468,400 | ........ | ........ | .......... | 59,206,750 | 290,723,700 |

TABLE 5 — SASH, DOORS, BLINDS AND GENERAL MILLWORK

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| White pine | 116,420,300 | 34.11 | $32 42 | $3,774,443 | 52,000,000 | 64,420,300 |
| Cypress (bald) | 29,617,270 | 8.68 | 37 60 | 1,113,671 | .......... | 29,617,270 |
| Hemlock | 26,436,600 | 7.75 | 20 44 | 540,352 | 11,187,600 | 15,249,000 |
| White oak | 25,801,500 | 7.56 | 49 78 | 1,284,369 | 3,436,600 | 22,364,900 |
| Red gum | 23,494,000 | 6.88 | 27 53 | 646,798 | .......... | 23,494,000 |
| Shortleaf pine | 21,105,200 | 6.18 | 28 30 | 597,359 | .......... | 21,105,200 |
| Chestnut | 13,324,200 | 3.90 | 36 17 | 481,983 | 2,900,500 | 10,423,700 |
| Spruce | 12,721,600 | 3.73 | 23 34 | 296,966 | 5,439,600 | 7,282,000 |
| Longleaf pine | 12,650,615 | 3.71 | 32 22 | 407,601 | .......... | 12,650,615 |
| Yellow poplar | 10,908,750 | 3.20 | 42 75 | 466,374 | 1,283,500 | 9,625,250 |
| Birch | 10,695,800 | 3.13 | 35 55 | 380,258 | 5,004,900 | 5,690,900 |
| Red oak | 9,609,400 | 2.82 | 45 76 | 439,695 | 3,597,300 | 6,012,100 |
| Sugar maple | 6,383,200 | 1.87 | 27 22 | 173,669 | 2,879,200 | 3,504,000 |
| Basswood | 5,027,400 | 1.47 | 27 47 | 138,088 | 2,537,000 | 2,490,400 |
| Western white pine | 2,462,000 | .72 | 41 37 | 101,865 | .......... | 2,462,000 |
| Other species | 14,619,327 | ........ | ........ | .......... | .......... | .......... |
| Total | 341,277,162 | ........ | ........ | .......... | 90,266,200 | 236,391,635 |

TABLE 6 — FURNITURE

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| White oak | 32,413,100 | 31.03 | $51 27 | $1,661,908 | 6,047,950 | 26,365,150 |
| Birch | 10,040,382 | 9.61 | 26 34 | 264,446 | 7,937,932 | 2,102,450 |
| Red oak | 10,017,200 | 9.59 | 42 47 | 425,402 | 3,317,800 | 6,699,400 |
| Chestnut | 9,752,590 | 9.34 | 23 00 | 224,274 | 1,625,500 | 8,127,090 |
| Sugar maple | 8,351,900 | 8.00 | 28 62 | 238,909 | 5,117,400 | 3,234,500 |
| Yellow poplar | 6,056,780 | 5.80 | 38 76 | 234,773 | 477,500 | 5,579,280 |
| Basswood | 5,326,200 | 5.10 | 25 16 | 134,020 | 1,880,200 | 3,446,000 |
| Beech | 4,958,000 | 4.75 | 19 77 | 97,997 | 3,296,000 | 1,662,000 |
| Red gum | 3,666,825 | 3.51 | 31 06 | 113,888 | .......... | 3,666,825 |
| Mahogany | 3,608,027 | 3.45 | 128 46 | 463,472 | .......... | 3,608,027 |
| White pine | 2,153,000 | 2.06 | 31 26 | 67,300 | 1,190,500 | 962,500 |
| Hemlock | 1,570,000 | 1.50 | 14 11 | 22,150 | 55,000 | 1,515,000 |
| Ash | 1,423,625 | 1.36 | 27 20 | 38,716 | 959,325 | 464,300 |
| Silver maple | 1,335,500 | 1.28 | 32 32 | 43,166 | 399,000 | 936,500 |
| Cypress (bald) | 735,300 | .70 | 31 95 | 23,492 | .......... | 735,300 |
| Other species | 3,095,863 | ........ | ........ | .......... | .......... | .......... |
| Total | 104,504,202 | ........ | ........ | .......... | 32,304,107 | 69,104,322 |

### Table 7 — Car Construction

| Kind of Wood | Quantity used annually: Feet b. m. | Quantity used annually: Per cent | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| Shortleaf pine | 24,554,800 | 32.22 | $28 51 | $700,146 | ........... | 24,554,800 |
| White oak | 13,823,100 | 18.14 | 27 73 | 383,289 | 1,021,000 | 12,802,100 |
| Longleaf pine | 11,638,500 | 15.27 | 30 61 | 356,203 | ........... | 11,638,500 |
| Red oak | 11,077,000 | 14.53 | 26 59 | 294,557 | 641,000 | 10,436,000 |
| Norway pine | 5,250,000 | 6.89 | 24 76 | 130,000 | ........... | 5,250,000 |
| Spruce | 2,623,000 | 3.44 | 23 30 | 61,119 | 345,000 | 2,278,000 |
| Loblolly pine | 1,981,000 | 2.60 | 23 84 | 47,220 | ........... | 1,981,000 |
| Hemlock | 1,560,000 | 2.05 | 19 38 | 30,240 | 315,000 | 1,245,000 |
| White pine | 1,164,500 | 1.53 | 33 66 | 39,197 | 726,000 | 438,500 |
| Yellow poplar | 896,800 | 1.18 | 57 52 | 51,584 | 10,000 | 886,800 |
| Other species | 1,633,200 | ........ | ........ | .......... | ........... | ........... |
| Total | 76,201,900 | ........ | ........ | .......... | 3,058,000 | 71,510,700 |

### Table 8 — Musical Instruments

| Kind of Wood | Quantity used annually: Feet b. m. | Quantity used annually: Per cent | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| Sugar maple | 10,445,900 | 17.76 | $35 28 | $368,576 | 4,871,300 | 5,574,600 |
| Yellow poplar | 9,933,300 | 16.89 | 48 86 | 485,355 | 1,011,200 | 8,922,100 |
| Spruce | 9,557,950 | 16.25 | 24 27 | 232,004 | 8,865,700 | 692,250 |
| Red gum | 4,100,200 | 6.97 | 38 42 | 157,523 | ......... | 4,100,200 |
| Chestnut | 3,596,000 | 6.11 | 23 42 | 84,236 | 124,000 | 3,472,000 |
| Basswood | 3,513,600 | 5.97 | 37 64 | 132,250 | 1,328,600 | 2,185,000 |
| White oak | 3,481,500 | 5.92 | 62 79 | 218,605 | 504,250 | 2,977,250 |
| Mahogany | 2,934,200 | 4.99 | 149 58 | 438,908 | ......... | 2,934,200 |
| Birch | 2,791,500 | 4.75 | 30 19 | 84,276 | 2,036,500 | 755,000 |
| Red oak | 2,168,000 | 3.69 | 63 58 | 137,850 | 401,250 | 1,766,750 |
| Other species | 6,294,300 | ...... | ...... | ........ | ......... | .......... |
| Total | 58,816,450 | ...... | ...... | ........ | 9,142,800 | 3,379,350 |

### Table 9 — Dairymen's, Poulterers' and Apiarists' Supplies

| Kind of Wood | Quantity used annually | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Chestnut | 20,388,100 | 52.22 | $31 66 | $645,421 | 500,000 | 19,988,100 |
| Basswood | 6,104,000 | 15.63 | 22 53 | 137,521 | 4,082,000 | 2,022,000 |
| White pine | 4,653,300 | 11.92 | 25 68 | 119,515 | 686,300 | 3,967,000 |
| Elm | 1,843,600 | 4.72 | 20 28 | 37,391 | 1,450,000 | 393,600 |
| Yellow poplar | 1,725,200 | 4.42 | 29 89 | 51,558 | 125,000 | 1,600,200 |
| Spruce | 1,057,000 | 2.71 | 22 95 | 24,262 | 907,000 | 150,000 |
| Beech | 663,600 | 1.70 | 19 12 | 12,691 | 539,600 | 124,000 |
| Other species | 2,611,200 | ...... | ...... | ........ | ......... | .......... |
| Total | 39,046,000 | ...... | ...... | ........ | 8,289,900 | 29,378,900 |

### Table 10 — Ship and Boat Building

| Kind of Wood | Quantity used annually | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Longleaf pine | 19,354,500 | 51.34 | $33 97 | $657,383 | ......... | 19,354,500 |
| White oak | 6,313,500 | 16.75 | 48 70 | 307,495 | 2,005,000 | 4,308,500 |
| White pine | 2,815,700 | 7.47 | 57 75 | 162,593 | 1,375,200 | 1,440,500 |
| Spruce | 1,877,397 | 4.98 | 36 04 | 67,669 | 480,000 | 1,397,397 |
| Shortleaf pine | 1,626,300 | 4.31 | 29 50 | 47,980 | ......... | 1,626,300 |
| Red oak | 1,280,400 | 3.40 | 45 76 | 58,596 | 272,900 | 1,007,500 |
| Douglas fir | 565,000 | 1.50 | 56 17 | 31,737 | ......... | 565,000 |
| Sugar maple | 422,500 | 1.12 | 36 33 | 15,351 | 347,500 | 75,000 |
| Other species | 3,445,203 | ...... | ...... | ........ | ......... | .......... |
| Total | 37,700,500 | ...... | ...... | ........ | 4,480,600 | 29,774,697 |

TABLE 11 — VEHICLE AND VEHICLE PARTS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Hickory | 6,874,350 | 22.44 | $44 00 | $302,450 | 1,429,250 | 5,445,100 |
| White oak | 5,134,750 | 16.76 | 48 47 | 248,884 | 1,959,050 | 3,175,700 |
| Ash | 5,128,000 | 16.74 | 45 53 | 233,471 | 2,151,500 | 2,976,500 |
| Yellow poplar | 2,701,900 | 8.82 | 62 90 | 169,961 | 488,600 | 2,213,300 |
| Red oak | 2,586,200 | 8.44 | 48 07 | 124,312 | 696,200 | 1,890,000 |
| Sugar maple | 1,984,400 | 6.48 | 31 61 | 62,722 | 1,085,900 | 898,500 |
| Basswood | 1,622,450 | 5.30 | 31 67 | 51,391 | 957,150 | 665,300 |
| Birch | 1,455,000 | 4.75 | 37 63 | 54,757 | 696,700 | 758,300 |
| Beech | 718,000 | 2.34 | 18 94 | 13,601 | 668,000 | 50,000 |
| Elm | 441,950 | 1.44 | 25 39 | 11,221 | 285,150 | 156,800 |
| Other species | 1,866,100 | ...... | ...... | ........ | ......... | .......... |
| Total | 30,513,100 | ...... | ...... | ........ | 10,417,500 | 19,510,800 |

TABLE 12 — AGRICULTURAL IMPLEMENTS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Sugar maple | 7,970,750 | 28.41 | $28 84 | $229,860 | 2,699,500 | 5,271,250 |
| Longleaf pine | 3,371,200 | 12.02 | 36 97 | 124,636 | ......... | 3,371,200 |
| Shortleaf pine | 2,911,000 | 10.38 | 37 96 | 110,503 | ......... | 2,911,000 |
| Spruce | 2,279,500 | 8.12 | 20 80 | 47,417 | 141,000 | 2,138,500 |
| Red gum | 1,542,000 | 5.50 | 26 19 | 40,386 | ......... | 1,542,000 |
| White oak | 1,539,000 | 5.48 | 41 02 | 63,135 | 1,052,000 | 487,000 |
| Basswood | 1,367,000 | 4.87 | 28 60 | 39,097 | 1,127,000 | 240,000 |
| Beech | 1,322,000 | 4.71 | 25 33 | 33,490 | 1,322,000 | .......... |
| Ash | 1,118,200 | 3.99 | 34 76 | 38,873 | 671,200 | 447,000 |
| Elm | 833,000 | 2.97 | 27 72 | 23,090 | 427,000 | 406,000 |
| Other species | 3,801,850 | ...... | ...... | ........ | ......... | .......... |
| Total | 28,055,500 | ...... | ...... | ........ | 7,439,700 | 16,813,950 |

TABLE 13 — BOOT AND SHOE FINDINGS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Sugar maple...... | 21,196,000 | 92.63 | $24 15 | $511,806 | 18,096,000 | 3,100,000 |
| Basswood......... | 1,241,000 | 5.42 | 36 46 | 45,241 | 1,094,000 | 147,000 |
| Other species..... | 345,000 | ...... | ...... | ........ | ......... | .......... |
| Total........ | 22,782,000 | ...... | ...... | ........ | 19,190,000 | 3,247,000 |

TABLE 14 — CHAIRS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| White oak........ | 6,897,100 | 31.91 | $45 40 | $313,126 | 3,139,000 | 3,758,100 |
| Red oak.......... | 4,080,500 | 18.88 | 39 69 | 161,935 | 1,608,000 | 2,472,500 |
| Birch............ | 2,889,500 | 13.37 | 31 02 | 89,624 | 2,730,500 | 159,000 |
| Sugar maple...... | 2,639,300 | 12.21 | 23 86 | 62,982 | 1,877,800 | 761,500 |
| Beech............ | 1,467,500 | 6.79 | 18 98 | 27,853 | 1,354,500 | 113,000 |
| Other species..... | 3,638,300 | ...... | ...... | ........ | ......... | .......... |
| Total........ | 21,611,400 | ...... | ...... | ........ | 10,709,800 | 7,264,100 |

TABLE 15 — FIXTURES

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| White oak | 4,470,000 | 22.16 | $60 75 | $271,563 | 1,990,500 | 2,479,500 |
| Yellow poplar | 3,023,250 | 14.98 | 43 27 | 130,817 | 233,000 | 2,790,250 |
| Sugar maple | 2,215,000 | 10.98 | 28 19 | 62,440 | 112,000 | 2,103,000 |
| Red oak | 1,898,500 | 9.41 | 44 57 | 84,615 | 695.000 | 1,203,500 |
| Chestnut | 1,828,100 | 9.06 | 25 84 | 47,245 | 1,275,800 | 552,300 |
| Cherry (black) | 1,150,000 | 5.70 | 47 43 | 54,550 | 55,000 | 1,095,000 |
| Mahogany | 1,056,800 | 5.24 | 138 56 | 146,428 | ......... | 1,056,800 |
| Birch | 1,055,500 | 5.23 | 46 61 | 49,195 | 537,500 | 518,000 |
| Elm | 723,000 | 3.58 | 36 78 | 26,590 | 23,000 | 700,000 |
| White pine | 704,400 | 3.49 | 43 95 | 30,956 | 521,400 | 183,000 |
| Other species | 2,051,065 | ...... | ...... | ........ | ......... | .......... |
| Total | 20,215,615 | ...... | ...... | ........ | 5,443,200 | 12,681,350 |

TABLE 16 — PROFESSIONAL AND SCIENTIFIC INSTRUMENTS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Red cedar | 15,750,000 | 79.50 | $37 55 | $591,375 | ......... | 15,750,000 |
| Basswood | 1,748,200 | 8.82 | 34 29 | 59,954 | 1,069,200 | 679,000 |
| Sugar maple | 862,000 | 4.35 | 38 39 | 33,089 | 247,000 | 615,000 |
| Yellow poplar | 475,000 | 2.40 | 47 37 | 22,500 | ......... | 475,000 |
| Cherry (black) | 315,700 | 1.59 | 53 71 | 16,957 | 60,000 | 255,700 |
| Other species | 660,900 | ...... | ...... | ........ | ......... | .......... |
| Total | 19,811,800 | ...... | ...... | ........ | 1,376,200 | 17,774,700 |

Only about 76,000 cords of hemlock bark are now cut annually in New York. Formerly several hundred thousand cords were cut every year. Very few virgin stands of hemlock such as this are to be found in the State. Thousands of acres of fine hemlock stands in the Catskills and in the southwestern counties were sacrificed from twenty to forty years ago for their bark alone. Photograph by NELSON C. BROWN.

Table 17 — Caskets and Coffins

| Kind of Wood | Quantity used annually | | Average cost per 1,000 feet | Total cost f. o b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Chestnut | 9,199,000 | 50.65 | $24 12 | $221,897 | 380,000 | 8,819,000 |
| White pine | 4,331,000 | 23.85 | 28 20 | 122,129 | 173,000 | 4,158,000 |
| White oak | 1,658,000 | 9.13 | 54 84 | 90,926 | 16,000 | 1,642,000 |
| Yellow poplar | 979,000 | 5.39 | 35 25 | 34,506 | ......... | 979,000 |
| Mahogany | 510,000 | 2.81 | 134 27 | 68,478 | ......... | 510,000 |
| Red oak | 481,000 | 2.65 | 45 72 | 21,992 | 16,000 | 465,000 |
| Cypress (bald) | 425,000 | 2.34 | 48 11 | 20,445 | ......... | 425,000 |
| Other species | 578,000 | ...... | ...... | ......... | ......... | .......... |
| Total | 18,161,000 | ...... | ...... | ......... | 585,000 | 17,028,000 |

Table 18 — Baskets and Fruit Packages

| Kind of Wood | Quantity used annually | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Beech | 4,013,500 | 22.29 | $17 93 | $71,942 | 3,164,500 | 849,000 |
| Sugar maple | 2,480,400 | 13.77 | 17 60 | 43,653 | 2,265,400 | 215,000 |
| Elm | 2,260,550 | 12.55 | 17 95 | 40,570 | 2,036,550 | 224,000 |
| White pine | 1,857,000 | 10.31 | 20 25 | 37,597 | 782,000 | 1,075,000 |
| Basswood | 1,426,400 | 7.92 | 19 09 | 27,226 | 1,276,400 | 150,000 |
| Silver maple | 1,394,500 | 7.74 | 18 53 | 25,839 | 940,500 | 454,000 |
| Spruce | 1,205,000 | 6.69 | 18 68 | 22,510 | 655,000 | 550,000 |
| Hemlock | 719,000 | 3.99 | 16 56 | 11,906 | 689,000 | 30,000 |
| Birch | 714,000 | 3.97 | 18 74 | 13,382 | 702,000 | 12,000 |
| Cottonwood | 528,000 | 2.93 | 17 30 | 9,134 | 528,000 | .......... |
| Other species | 1,408,900 | ...... | ...... | ......... | ......... | .......... |
| Total | 18,007,250 | ...... | ...... | ......... | 14,145,250 | 3,862,000 |

TABLE 19 — EXCELSIOR

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Cottonwood | 11,964,000 | 81.41 | $16 50 | $197,435 | 11,139,000 | 825,000 |
| Basswood | 2,080,000 | 14.15 | 18 03 | 37,510 | 1,980,000 | 100,000 |
| Yellow poplar | 603,000 | 4.10 | 20 31 | 12,245 | 603,000 | .......... |
| Butternut | 50,000 | .34 | 16 00 | 800 | 50,000 | .......... |
| Total | 14,697,000 | ...... | ...... | ........ | 13,772,000 | 925,000 |

TABLE 20 — REFRIGERATORS AND KITCHEN CABINETS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| White oak | 3,305,500 | 26.94 | $35 12 | $116,097 | 470,500 | 2,835,000 |
| Red oak | 1,935,500 | 15.78 | 34 73 | 67,216 | 145,500 | 1,790,000 |
| Ash | 1,798,500 | 14.66 | 28 83 | 51,859 | 859,500 | 939,000 |
| Spruce | 1,439,000 | 11.73 | 29 41 | 42,316 | 1,140,000 | 299,000 |
| White pine | 1,315,500 | 10.72 | 26 44 | 34,788 | 615,000 | 700,500 |
| Yellow poplar | 667,000 | 5.44 | 40 53 | 27,034 | 25,000 | 642,000 |
| Sugar maple | 378,500 | 3.09 | 23 95 | 9,064 | 28,500 | 350,000 |
| Red gum | 200,500 | 1.63 | 40 02 | 8,025 | ......... | 200,500 |
| Birch | 168,500 | 1.37 | 19 85 | 3,345 | 108,500 | 60,000 |
| Redwood | 155,000 | 1.26 | 39 84 | 6,175 | ......... | 155,000 |
| Other species | 905,200 | ...... | ...... | ........ | ......... | .......... |
| Total | 12,268,700 | ...... | ...... | ........ | 3,392,500 | 7,971,000 |

TABLE 21 — TANKS AND SILOS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Cypress (bald).... | 2,580,550 | 22.77 | $40 45 | $104,384 | ......... | 2,580,550 |
| Spruce........... | 2,370,000 | 20.91 | 21 94 | 52,005 | 85,000 | 2,285,000 |
| Hemlock......... | 1,190,000 | 10.50 | 24 39 | 29,030 | 380,000 | 810,000 |
| White oak........ | 1,130,000 | 9.97 | 32 95 | 37,230 | 105,000 | 1,025,000 |
| White pine....... | 1,090,300 | 9.62 | 31 41 | 34,241 | 665,300 | 425,000 |
| Red pine......... | 950,000 | 8.38 | 29 37 | 27,900 | ......... | 950,000 |
| Ash............. | 500,000 | 4.41 | 25 00 | 12,500 | ......... | 500,000 |
| Western larch..... | 420,000 | 3.71 | 29 40 | 12,350 | ......... | 420,000 |
| Longleaf pine..... | 408,700 | 3.61 | 28 67 | 11,716 | ......... | 408,700 |
| Arborvitae (northern white cedar) | 240,000 | 2.12 | 37 50 | 9,000 | ......... | 240,000 |
| Other species..... | 453,400 | ...... | ...... | ........ | ......... | .......... |
| Total........ | 19,788,800 | ...... | ...... | ........ | 1,235,300 | 9,644,250 |

TABLE 22 — CIGAR BOXES

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Spanish cedar..... | 8,580,500 | 84.82 | $113 08 | $970,298 | ......... | 8,580,500 |
| Cotton gum...... | 891,800 | 8.82 | 48 14 | 42,933 | ......... | 891,800 |
| Yellow poplar..... | 264,000 | 2.61 | 41 63 | 10,990 | ......... | 264,000 |
| Other species..... | 379,250 | ...... | ...... | ........ | ......... | .......... |
| Total........ | 10,115,550 | ...... | ...... | ........ | ......... | 9,736,300 |

TABLE 23 — PUMPS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| White pine | 8,197,000 | 83.60 | $29 96 | $245,610 | 1,187,000 | 7,010,000 |
| Silver maple | 550,000 | 5.61 | 25 00 | 13,750 | 275,000 | 275,000 |
| Sugar maple | 506,000 | 5.16 | 21 97 | 11,118 | 6,000 | 500,000 |
| Cypress (bald) | 500,000 | 5.10 | 22 50 | 11,250 | ........ | 500,000 |
| Other species | 51,800 | ...... | ...... | ........ | ......... | .......... |
| Total | 9,804,800 | ...... | ...... | ........ | 1,468,000 | 8,285,000 |

TABLE 24 — WOODENWARE AND NOVELTIES

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Spruce | 1,949,000 | 23.30 | $32 88 | $64,073 | 884,000 | 1,065,000 |
| Basswood | 1,721,200 | 20.58 | 30 13 | 51,856 | 1,451,200 | 270,000 |
| Beech | 1,014,000 | 12.12 | 15 59 | 15,812 | 1,014,000 | .......... |
| Ash | 788,500 | 9.43 | 32 06 | 25,280 | 633,500 | 155,000 |
| Hickory | 568,500 | 6.80 | 43 24 | 24,582 | 408,500 | 160,000 |
| White pine | 438,500 | 5.24 | 29 01 | 12,722 | 257,500 | 181,000 |
| White oak | 406,000 | 4.85 | 42 53 | 17,268 | 210,000 | 196,000 |
| Sugar maple | 317,500 | 3.80 | 18 92 | 6,006 | 297,500 | 20,000 |
| Shortleaf pine | 220,000 | 2.63 | 16 18 | 3,560 | ......... | 220,000 |
| Birch | 187,500 | 2.24 | 20 41 | 3,826 | 167,500 | 20,000 |
| Yellow poplar | 145,500 | 1.74 | 39 90 | 5,805 | 26,500 | 119,000 |
| Red oak | 145,000 | 1.73 | 44 66 | 6,475 | 58,000 | 87,000 |
| Elm | 109,000 | 1.30 | 18 40 | 2,006 | 109,000 | .......... |
| Other species | 354,700 | ...... | ...... | ........ | ......... | .......... |
| Total | 8,364,900 | ...... | ...... | ........ | 5,517,200 | 2,493,000 |

TABLE 25 — PICTURE FRAMES AND MOLDING

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| White oak........ | 3,005,500 | 40.00 | $45 87 | $137,860 | 480,500 | 2,525,000 |
| Basswood........ | 1,137,500 | 15.14 | 39 44 | 44,858 | 174,000 | 963,500 |
| Yellow poplar..... | 749,250 | 9.97 | 42 67 | 31,969 | 102,000 | 647,250 |
| Birch........... | 647,000 | 8.61 | 46 33 | 29,975 | 543,500 | 103,500 |
| Red oak.......... | 365,500 | 4.86 | 47 40 | 17,325 | 120,000 | 245,500 |
| Other species..... | 1,609,700 | ...... | ...... | ........ | ......... | .......... |
| Total........ | 7,514,450 | ...... | ...... | ........ | 1,420,000 | 4,484,750 |

TABLE 26 — HANDLES

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Beech........... | 3,076,000 | 47.52 | $17 80 | $54,767 | 2,973,000 | 103,000 |
| Sugar maple...... | 1,418,000 | 21.90 | 18 57 | 26,329 | 1,350,000 | 68,000 |
| Birch........... | 861,000 | 13.30 | 13 77 | 11,852 | 861,000 | .......... |
| Ash............. | 466,400 | 7.20 | 29 91 | 13,952 | 251,400 | 215,000 |
| White oak........ | 336,500 | 5.20 | 40 59 | 13,660 | 232,500 | 104,000 |
| Hickory.......... | 204,150 | 3.15 | 39 57 | 8,078 | 153,000 | 51,150 |
| Other species..... | 80,929 | ...... | ...... | ........ | ......... | .......... |
| Total........ | 6,442,979 | ...... | ...... | ........ | 5,820,900 | 541,150 |

TABLE 27 — LAUNDRY APPLIANCES

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Cypress (bald) | 2,032,300 | 39.07 | $37 17 | $75,541 | ......... | 2,032,300 |
| Basswood | 1,010,670 | 19.43 | 24 02 | 24,272 | 905,000 | 105,670 |
| Sugar maple | 819,000 | 15.75 | 23 44 | 19,195 | 269,000 | 550,000 |
| Beech | 575,000 | 11.06 | 20 13 | 11,575 | 225,000 | 350,000 |
| Yellow poplar | 311,200 | 5.98 | 44 89 | 13,970 | 7,500 | 303,700 |
| Other species | 493,170 | ...... | ...... | ........ | ......... | .......... |
| Total | 5,241,340 | ...... | ...... | ........ | 1,406,500 | 3,341,670 |

TABLE 28 — ELECTRICAL MACHINERY AND APPARATUS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Spruce | 1,343,000 | 29.18 | $23 69 | $31,817 | 593,000 | 750,000 |
| Arborvitae (northern white cedar) | 735,000 | 15.97 | 11 01 | 8,085 | 735,000 | .......... |
| Beech | 375,000 | 8.15 | 16 40 | 6,150 | 25,000 | 350,000 |
| White oak | 330,500 | 7.18 | 40 51 | 13,400 | 145,500 | 185,000 |
| White pine | 284,000 | 6.17 | 28 59 | 8,120 | 264,000 | 20,000 |
| Yellow poplar | 230,000 | 5.00 | 34 67 | 7,874 | ......... | 230,000 |
| Other species | 1,335,360 | ...... | ...... | ........ | ......... | .......... |
| Totals | 4,632,860 | ...... | ...... | ........ | 1,762,500 | 1,535,000 |

TABLE 29 — MACHINE CONSTRUCTION

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Sugar maple | 593,300 | 13.02 | $29 56 | $17,537 | 500,100 | 93,200 |
| Hemlock | 550,000 | 12.07 | 15 55 | 8,550 | 550,000 | .......... |
| Yellow poplar | 476,000 | 10.45 | 43 34 | 20,630 | 175,000 | 301,000 |
| Shortleaf pine | 350,000 | 7.68 | 29 44 | 10,305 | ......... | 350,000 |
| White oak | 299,700 | 6.58 | 54 39 | 16,301 | 237,700 | 62,000 |
| White pine | 274,500 | 6.02 | 26 25 | 7,205 | 245,500 | 29,000 |
| Ash | 268,000 | 5.88 | 51 42 | 13,780 | 166,000 | 102,000 |
| Elm | 267,000 | 5.86 | 29 76 | 7,945 | 234,000 | 33,000 |
| Basswood | 260,500 | 5.72 | 26 72 | 6,960 | 210,500 | 50,000 |
| Red oak | 256,500 | 5.63 | 52 18 | 13,383 | 194,500 | 62,000 |
| Spruce | 208,200 | 4.57 | 28 19 | 5,870 | 95,200 | 113,000 |
| Other species | 752,200 | ...... | ...... | ........ | ......... | .......... |
| Total | 4,555,900 | ...... | ...... | ........ | 2,608,500 | 1,195,200 |

TABLE 30 — SPORTING AND ATHLETIC GOODS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Sugar maple | 851,000 | 20.12 | $41 02 | $34,904 | 274,000 | 577,000 |
| White oak | 714,000 | 16.88 | 65 78 | 46,964 | 213,000 | 501,000 |
| Shortleaf pine | 592,000 | 13.99 | 37 75 | 22,348 | ......... | 592,000 |
| Red oak | 525,000 | 12.41 | 69 05 | 36,250 | 25,000 | 500,000 |
| Yellow poplar | 351,200 | 8.30 | 58 66 | 20,602 | 300,000 | 51,200 |
| Other species | 1,196,900 | ...... | ...... | ........ | ......... | .......... |
| Total | 4,230,100 | ...... | ...... | ........ | 812,000 | 2,221,200 |

TABLE 31 — TRUNKS AND VALISES

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Basswood | 2,260,500 | 63.93 | $33 32 | $75,325 | 1,085,500 | 1,175,000 |
| White pine | 750,500 | 21.22 | 29 21 | 21,925 | 75,500 | 675,000 |
| Elm | 340,000 | 9.62 | 34 41 | 11,700 | 50,000 | 290,000 |
| Hickory | 80,000 | 2.26 | 47 50 | 3,800 | ......... | 80,000 |
| Ash | 70,000 | 1.98 | 50 00 | 3,500 | ......... | 70,000 |
| Red gum | 35,000 | .99 | 33 57 | 1,175 | ......... | 35,000 |
| Total | 3,536,000 | . . | | . . . . | 1,211,000 | 2,325,000 |

TABLE 32 — PATTERNS AND FLASKS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| White pine | 2,908,400 | 85.84 | $51 58 | $150,002 | 681,800 | 2,226,600 |
| Basswood | 105,500 | 3.12 | 34 47 | 3,637 | 105,500 | .......... |
| White oak | 100,000 | 2.95 | 35 00 | 3,500 | 100,000 | .......... |
| Hemlock | 75,800 | 2.24 | 15 87 | 1,203 | 15,800 | 60,000 |
| Pitch pine | 60,000 | 1.77 | 24 33 | 1,460 | 60,000 | .......... |
| Other species | 138,600 | ...... | ...... | ........ | ......... | .......... |
| Total | 3,388,300 | ...... | ...... | ........ | 963,100 | 2,286,600 |

TABLE 33 — TOYS

| KIND OF WOOD | QUANTITY USED ANNUALLY Feet b. m. | Per cent | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| Basswood | 1,412,500 | 47.17 | $31 41 | $44,370 | 762,500 | 650,000 |
| Sugar maple | 960,500 | 32.08 | 23 12 | 22,210 | 710,500 | 250,000 |
| Ash | 232,000 | 7.75 | 25 78 | 5,980 | 212,000 | 20,000 |
| Chestnut | 125,000 | 4.17 | 21 80 | 2,725 | 100,000 | 25,000 |
| Birch | 100,000 | 3.34 | 20 00 | 2,000 | 50,000 | 50,000 |
| Red oak | 100,000 | 3.34 | 30 00 | 3,000 | 100,000 | .......... |
| Other species | 64,500 | .... | ...... | ......... | .......... | .......... |
| Total | 2,994,500 | ...... | ...... | ......... | 1,935,000 | 995,000 |

TABLE 34 — CLOCKS

| KIND OF WOOD | QUANTITY USED ANNUALLY Feet b. m. | Per cent | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| Loblolly pine | 926,571 | 31.43 | $19 50 | $18,068 | ......... | 926,571 |
| White oak | 711,227 | 24.12 | 42 42 | 30,167 | 161,227 | 550,000 |
| White pine | 456,064 | 15.47 | 34 10 | 15,552 | ......... | 456,064 |
| Cotton gum | 322,816 | 10.95 | 34 15 | 11,024 | ......... | 322,816 |
| Cherry (black) | 300,000 | 10.17 | 30 00 | 9,000 | ......... | 300,000 |
| Other species | 231,481 | ...... | ...... | ......... | ......... | .......... |
| Total | 2,948,159 | ...... | ...... | ......... | 161,227 | 2,555,451 |

TABLE 35 — ELEVATORS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Pitch pine | 1,234,000 | 46.33 | $22 41 | $27,648 | .......... | 1,234,000 |
| White oak | 530,000 | 19.90 | 39 39 | 20,875 | 175,000 | 355,000 |
| Sugar maple | 398,000 | 14.94 | 43 15 | 17,172 | 398,000 | .......... |
| Red oak | 150,000 | 5.63 | 40 00 | 6,000 | 50,000 | 100,000 |
| White pine | 127,500 | 4.79 | 33 76 | 4,305 | 10,000 | 117,500 |
| Other species | 233,700 | ...... | ...... | ........ | .......... | .......... |
| Total | 2,673,200 | ...... | ...... | ........ | 633,000 | 1,806,500 |

TABLE 36 — WHIPS, CANES, UMBRELLA STICKS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Beech | 2,035,000 | 90.97 | $23 16 | $47,125 | 2,000,000 | 35,000 |
| Hickory | 40,000 | 1.79 | 49 50 | 1,980 | .......... | 40,000 |
| Ash | 30,000 | 1.35 | 60 00 | 1,800 | .......... | 30,000 |
| Birch | 25,000 | 1.12 | 50 00 | 1,250 | .......... | 25,000 |
| Basswood | 20,000 | .89 | 40 00 | 800 | .......... | 20,000 |
| Other species | 87,000 | ...... | ...... | ........ | .......... | .......... |
| Total | 2,237,000 | ...... | ...... | ........ | 2,000,000 | 150,000 |

Woods bought by piece or weight:

| | | | |
|---|---|---|---|
| Bamboo | Hornbeam | Partridge | Scotch thistle |
| Congo | Lancewood | Pea | Weitzel |
| Corra | Malacca | Peach | Whangee |
| Furze | Orange | Rattan | Willow (osier) |
| Haw | | | |

TABLE 37 — PLUMBERS' WOODWORK

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| White oak | 690,000 | 38.61 | $37 83 | $26,100 | 375,000 | 315,000 |
| Red oak | 518,000 | 28.99 | 35 07 | 18,165 | 233,000 | 285,000 |
| Birch | 216,000 | 12.09 | 45 58 | 9,845 | 141,000 | 75,000 |
| Shortleaf pine | 200,000 | 11.19 | 28 75 | 5,750 | ........ | 200,000 |
| Ash | 96,000 | 5.37 | 33 54 | 3,220 | 90,000 | 6,000 |
| Other species | 67,000 | ...... | ...... | ........ | ........ | ........ |
| Total | 1,787,000 | ...... | ...... | ........ | 839,000 | 881,000 |

TABLE 38 — PRINTING MATERIAL

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Cherry (black) | 577,000 | 33.21 | $48 28 | $27,850 | 27,000 | 550,000 |
| Basswood | 290,500 | 16.72 | 30 00 | 8,715 | 290,500 | ........ |
| Chestnut | 250,000 | 14.39 | 18 00 | 4,500 | 250,000 | ........ |
| Shortleaf pine | 200,000 | 11.51 | 15 00 | 3,000 | ........ | 200,000 |
| White oak | 200,000 | 11.51 | 40 00 | 8,000 | ........ | 200,000 |
| Other species | 220,000 | ...... | ...... | ........ | ........ | ........ |
| Total | 1,737,500 | ...... | ...... | ........ | 567,500 | 950,000 |

TABLE 39 — SHADE AND MAP ROLLERS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| White pine | 1,000,000 | 61.63 | $42 50 | $42,500 | 125,000 | 875,000 |
| Red gum | 500,000 | 30.82 | 25 60 | 12,800 | ........ | 500,000 |
| Beech | 50,000 | 3.08 | 16 00 | 800 | 50,000 | ........ |
| Other species | 72,500 | ...... | ...... | ........ | ........ | ........ |
| Total | 1,622,500 | ...... | ...... | ........ | 175,000 | 1,375,000 |

TABLE 40 — BRUSHES AND BROOMS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Beech | 565,000 | 36.16 | $20 33 | $11,485 | 460,000 | 105,000 |
| Birch | 463,000 | 29.63 | 19 26 | 8,916 | 293,000 | 170,000 |
| Sugar maple | 201,500 | 12.89 | 27 30 | 5,500 | 166,500 | 35,000 |
| Basswood | 138,000 | 8.83 | 20 29 | 2,800 | 138,000 | ......... |
| White pine | 75,000 | 4.80 | 18 00 | 1,350 | 75,000 | ......... |
| Elm | 50,000 | 3.20 | 25 00 | 1,250 | 30,000 | 20,000 |
| Other species | 120,000 | ...... | ...... | ........ | ......... | ......... |
| Total | 1,612,500 | ...... | ...... | ........ | 1,162,500 | 330,000 |

TABLE 41 — SHUTTLES, SPOOLS AND BOBBINS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Birch | 552,000 | 57.38 | $20 92 | $11,550 | 452,000 | 100,000 |
| Beech | 200,000 | 20.79 | 16 00 | 3,200 | 200,000 | ......... |
| Sugar maple | 150,000 | 15.59 | 25 00 | 3,750 | 80,000 | 70,000 |
| Other species | 60,000 | ...... | ...... | ........ | ......... | ......... |
| Total | 962,000 | ...... | ...... | ........ | 732,000 | 170,000 |

TABLE 42 — PULLEYS AND CONVEYORS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Sugar maple | 400,000 | 48.60 | $19 75 | $7,900 | 225,000 | 175,000 |
| Birch | 160,000 | 19.44 | 40 00 | 6,400 | 60,000 | 100,000 |
| Ash | 150,000 | 18.23 | 50 00 | 7,500 | ......... | 150,000 |
| Lignum-vitae | 60,000 | 7.29 | 250 00 | 15,000 | ......... | 60,000 |
| Beech | 50,000 | 6.08 | 25 00 | 1,250 | 50,000 | ......... |
| Cypress (bald) | 3,000 | .36 | 59 00 | 177 | ......... | 3,000 |
| Total | 823,000 | ...... | ...... | ........ | 335,000 | 488,000 |

TABLE 43 — DOWELS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Birch | 516,000 | 72.51 | $40 01 | $21,862 | 516,000 | .......... |
| Beech | 181,000 | 24.01 | 18 66 | 3,378 | 131,000 | 50,000 |
| Basswood | 15,000 | 1.99 | 19 00 | 285 | 15,000 | .......... |
| Cherry (black) | 10,000 | 1.33 | 35 00 | 350 | 10,000 | .......... |
| Sugar maple | 1,000 | .13 | 16 00 | 16 | 1,000 | .......... |
| Total | 753,000 | ...... | ...... | ......... | 703,000 | 50,000 |

TABLE 44 — GATES AND FENCING

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Shortleaf pine | 200,000 | 27.57 | $25 00 | $5,000 | ......... | 200,000 |
| White pine | 158,500 | 21.85 | 25 27 | 4,005 | 158,500 | .......... |
| Red oak | 100,700 | 13.88 | 29 92 | 3,013 | 700 | 100,000 |
| Hemlock | 100,000 | 13.78 | 20 00 | 2,000 | ......... | 100,000 |
| White oak | 100,000 | 13.78 | 30 00 | 3,000 | ......... | 100,000 |
| Other species | 66,300 | ...... | ...... | ........ | ......... | .......... |
| Total | 725,500 | ...... | ...... | ........ | 159,200 | 500,000 |

TABLE 45 — SIGNS AND SUPPLIES

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| White pine | 585,000 | 97.59 | $27 50 | $16,085 | 25,000 | 560,000 |
| Red oak | 5,000 | .83 | 45 00 | 225 | 5,000 | .......... |
| Other species | 9,500 | ...... | ...... | ........ | ......... | .......... |
| Total | 599,500 | ...... | ...... | ........ | 30,000 | 560,000 |

TABLE 46 — FIREARMS

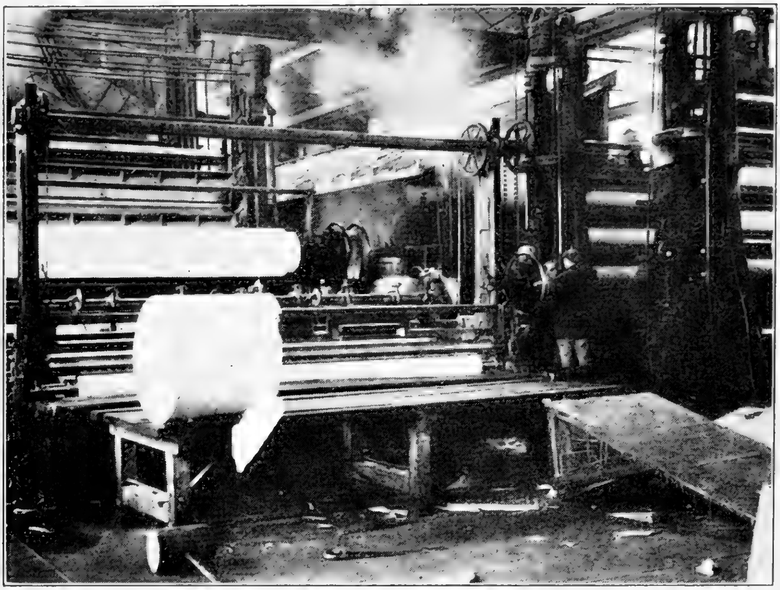
| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Black walnut..... | 370,000 | 100.00 | $68 65 | $25,400 | ......... | 370,000 |

TABLE 47 — PLAYGROUND EQUIPMENT

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Beech............ | 76,000 | 30.40 | $29 87 | $2,270 | 76,000 | .......... |
| Longleaf pine..... | 45,000 | 18.00 | 40 00 | 1,800 | .......... | 45,000 |
| Yellow poplar..... | 35,000 | 14.00 | 51 71 | 1,810 | 15,000 | 20,000 |
| Birch............ | 30,000 | 12.00 | 30 00 | 900 | 30,000 | .......... |
| White pine....... | 30,000 | 12.00 | 39 67 | 1,190 | 10,000 | 20,000 |
| Other species..... | 34,000 | .... | ...... | ...... | .......... | .......... |
| Total........ | 250,000 | ...... | ...... | ......... | 131,000 | 85,000 |

TABLE 48 — AEROPLANES

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| Spruce........... | 15,200 | 48.41 | $22 63 | $344 | 10,200 | 5,000 |
| Ash.............. | 6,500 | 20.70 | 35 08 | 228 | 4,500 | 2,000 |
| Yellow poplar..... | 4,200 | 13.38 | 40 00 | 168 | 1,000 | 3,200 |
| White oak........ | 3,500 | 11.14 | 42 29 | 148 | 1,500 | 2,000 |
| Hickory.......... | 2,000 | 6.37 | 40 00 | 80 | ......... | 2,000 |
| Total........ | 31,400 | ...... | ...... | ......... | 17,200 | 14,200 |



The final step in paper manufacture. Here the finished paper is taken from the paper machine, made up into rolls of the required size, wrapped and labelled for shipment. This machine is by far the largest and most expensive item in the equipment of the modern pulp mill.

Photograph by Henry H. Tryon.

TABLE 49 — MISCELLANEOUS

| KIND OF WOOD | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Total cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | | |
| White pine | 13,750,000 | 44.66 | $32 80 | $451,000 | 1,000,000 | 12,750,000 |
| Spruce | 5,754,000 | 18.69 | 24 35 | 140,100 | 2,504,000 | 3,250,000 |
| Loblolly pine | 3,850,000 | 12.51 | 20 45 | 78,750 | ......... | 3,850,000 |
| Red gum | 1,500,000 | 4.87 | 35 00 | 52,500 | ......... | 1,500,000 |
| White oak | 1,060,000 | 3.44 | 40 06 | 42,460 | 10,000 | 1,050,000 |
| Beech | 1,035,000 | 3.36 | 21 69 | 22,450 | 135,000 | 900,000 |
| Longleaf pine | 1,000,000 | 3.25 | 35 00 | 35,000 | ......... | 1,000,000 |
| Ash | 800,000 | 2.60 | 40 00 | 32,000 | ......... | 800,000 |
| Yellow poplar | 715,000 | 2.32 | 34 91 | 24,960 | ......... | 715,000 |
| Sugar maple | 706,000 | 2.29 | 30 04 | 21,210 | ......... | 706,000 |
| Other species | 620,300 | ...... | ...... | ........ | ......... | .......... |
| Total | 30,790,300 | ...... | ....... | ........ | 3,649,000 | 26,521,000 |

# PART III

## Tables Showing How Each Species is Used

These are arranged in numerical order and show for each species the amount of lumber used in each industry, the average price paid and whether the stock is native to New York or imported from other states or Canada.

TABLE 50 — WHITE PINE

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Boxes and crates, packing | 132,945,200 | 31.36 | $20 89 | 24,747,700 | 108,197,500 |
| Planing mill products | 121,512,700 | 28.52 | 28 05 | 69,044,900 | 52,467,800 |
| Sash, blinds, doors and general miscellaneous | 116,420,300 | 27.50 | 32 42 | 52,000,000 | 64,420,300 |
| Miscellaneous | 13,750,000 | 3.2 | 32 80 | 1,000,000 | 12,750,000 |
| Pumps | 8,197,000 | 1.93 | 29 96 | 1,187,000 | 7,010,000 |
| Dairy, poulterers, etc | 4,653,300 | 1.1 | 25 68 | 686,300 | 3,967,000 |
| Caskets and coffins | 4,331,000 | 1.020 | 28 20 | 173,000 | 4,158,000 |
| Boats and ships | 2,815,700 | 0.66 | 57 75 | 1,375,200 | 1,440,500 |
| Furniture | 2,153,000 | 0.60 | 31 26 | 1,190,500 | 962,500 |
| Baskets and fruit packages | 1,857,000 | 0.44 | 20 25 | 782,000 | 1,175,000 |
| Refrigerators and kitchen cabinets | 1,315,500 | 0.31 | 26 44 | 615,000 | 700,500 |
| Musical instruments | 1,251,500 | 0.29 | 53 39 | 416,300 | 835,200 |
| Car construction | 1,164,500 | 0.27 | 33 66 | 726,000 | 438,500 |
| Tanks and silos | 1,090,300 | 0.24 | 31 41 | 665,300 | 425,000 |
| Shade and map rollers | 1,000,000 | 0.23 | 42 50 | 125,000 | 875,000 |
| Agricultural implements | 782,000 | 0.18 | 31 56 | 611,000 | 171,000 |
| Trunks and valises | 750,000 | 0.17 | 29 21 | 75,600 | 675,000 |
| Fixtures | 704,400 | 0.16 | 43 95 | 521,400 | 183,000 |
| Signs | 585,000 | 0.14 | 27 50 | 25,000 | 560,000 |
| Vehicles | 181,100 | ...... | 40 60 | 77,600 | 103,500 |
| Chairs | 35,000 | ...... | 30 71 | 35,000 | .......... |
| Professional and scientific instruments | 71,500 | ...... | 51 05 | 1,500 | 70,000 |
| Woodenware, novelties, etc | 438,500 | ...... | 29 01 | 257,500 | 181,000 |
| Picture frames and mouldings | 269,500 | ...... | 35 65 | 229,500 | 40,000 |
| Handles | 10,000 | ...... | 32 00 | 10,000 | .......... |
| Laundry appliances | 36,670 | ...... | 44 77 | 36,000 | 670 |
| Electrical machinery and apparatus | 284,000 | ...... | 28 59 | 264,000 | 20,000 |
| Machinery construction | 274,500 | ...... | 26 25 | 245,500 | 29,000 |
| Sporting and athletic goods | 51,500 | ...... | 41 17 | 50,000 | 1,500 |
| Clocks | 456,064 | ...... | 34 10 | .......... | 456,064 |
| Elevators | 127,500 | ...... | 33 76 | 10,000 | 117,500 |
| Brushes and brooms | 75,000 | ...... | 18 00 | 75,000 | .......... |
| Gates and fencing | 158,500 | ...... | 25 27 | 158,500 | .......... |
| Playground equipment | 30,000 | ...... | 39 67 | 10,000 | 20,000 |
| Total | 419,777,734 | *97.72 | ...... | 157,427,300 | 262,451,034 |

* All others (less than 500 M) = 2.28 per cent.

TABLE 51 — SPRUCE

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Planing mill products | 75,416,560 | 44.59 | $20 77 | 37,818,800 | 37,597,760 |
| Boxes and crates, packing | 48,316,900 | 28.57 | 19 85 | 15,477,400 | 32,884,500 |
| Sash, doors, blinds and general mill work | 12,721,600 | 7.52 | 23 34 | 5,439,600 | 7,282,000 |
| Musical instruments | 9,557,950 | 5.65 | 24 27 | 8,865,700 | 692,250 |
| Miscellaneous | 5,754,000 | 3.40 | 24 35 | 2,504,000 | 3,250,000 |
| Car construction | 2,623,000 | 1.55 | 23 30 | 345,000 | 2,278,000 |
| Tanks and silos | 2,370,000 | 1.40 | 21 94 | 85,000 | 2,285,000 |
| Agricultural implements | 2,279,500 | 1.36 | 20 80 | 141,000 | 2,138,500 |
| Ship and boat building | 1,877,397 | 1.11 | 36 04 | 480,000 | 1,397,397 |
| Woodenware and novelties | 1,949,000 | 1.15 | ...... | 884,000 | 1,065,000 |
| Refrigerators and kitchen cabinets | 1,439,000 | 0.86 | 29 41 | 1,140,000 | 299,000 |
| Electric machinery | 1,343,000 | .79 | ...... | 593,000 | 750,000 |
| Baskets and fruit packages | 1,205,000 | 0.71 | 18 68 | 655,000 | 550,000 |
| Dairymen's, poulterers' and apiarists' supplies | 1,057,000 | 0.619 | 22 95 | 907,000 | 150,000 |
| Vehicles and vehicle parts | 253,000 | 0.148 | 29 07 | 220,000 | 33,000 |
| Picture frames and mouldings | 225,000 | 0.15 | 28 00 | 225,000 | .......... |
| Machinery construction | 208,200 | 0.12 | 28 19 | 95,200 | 113,000 |
| Sporting and athletic goods | 172,800 | 0.10 | 22 07 | 172,800 | .......... |
| Fixtures | 114,000 | 0.083 | 31 52 | 40,700 | 100,300 |
| Gates and fencing | 35,000 | 0.02 | 28 00 | ......... | 35,000 |
| Elevators | 24,000 | 0.014 | 37 00 | ......... | 24,000 |
| Professional and scientific instruments | 16,000 | .009 | 47 00 | 16,000 | .......... |
| Patterns and flasks | 15,000 | 0.009 | 24 67 | ......... | 15,000 |
| Aeroplanes | 15,200 | 0.009 | 22 63 | 10,200 | 5,000 |
| Furniture | 47,500 | ...... | 24 65 | 47,500 | .......... |
| Total | 169,020,607 | *99.27 | ...... | 76,162,900 | 92,944,707 |

* All others (less than 500 M) = 0.73 per cent.

TABLE 52 — WHITE OAK

| Name of Industry | Quantity used annually | | Average cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Furniture | 32,413,100 | 24.85 | $51 27 | 6,047,950 | 26,365,150 |
| Sash, doors, blinds and general mill work | 25,801,500 | 19.85 | 49 78 | 3,436,600 | 15,249,000 |
| Planing mill products | 15,337,100 | 11.68 | 41 09 | 5,926,100 | 9,411,000 |
| Car construction | 15,823,100 | 10.59 | 27 73 | 1,021,000 | 12,802,100 |
| Chairs | 6,897,100 | 5.28 | 45 40 | 3,139,000 | 3,758,100 |
| Ship and boat building | 6,313,500 | 4.84 | 48 70 | 2,005,000 | 4,308,500 |
| Vehicles and vehicle parts | 5,134,750 | 3.93 | 48 47 | 1,959,050 | 3,175,700 |
| Fixtures | 4,470,000 | 3.34 | 60 75 | 1,990,500 | 2,479,500 |
| Musical instruments | 3,481,500 | 2.66 | 62 79 | 504,250 | 2,977,250 |
| Refrigerators and kitchen cabinets | 3,305,500 | 2.53 | 35 12 | 470,500 | 2,835,000 |
| Picture frames and mouldings | 3,005,500 | 2.30 | 45 87 | 480,500 | 2,525,000 |
| Caskets and coffins | 1,658,000 | 1.29 | 54 84 | 16,000 | 1,642,000 |
| Agricultural implements | 1,539,000 | 1.17 | 41 02 | 1,052,000 | 487,000 |
| Tanks and silos | 1,130,000 | 0.86 | 32 95 | 105,000 | 1,025,000 |
| Miscellaneous | 1,060,000 | 0.81 | 40 06 | 10,000 | 1,050,000 |
| Sporting and athletic goods | 714,000 | 0.54 | 65 78 | 213,000 | 501,000 |
| Clocks | 711,227 | 0.54 | 42 42 | 161,227 | 550,000 |
| Plumbers' supplies | 690,000 | 0.52 | 37 83 | 375,000 | 315,000 |
| Elevators | 500,000 | 0.40 | ...... | 175,000 | 355,000 |
| Dairymen's, poulterers' and apiarists' supplies | 100,500 | ...... | 30 47 | 80,500 | 20,000 |
| Professional and scientific instruments | 57,500 | ...... | 51 70 | 15,000 | 42,500 |
| Baskets and fruit packages | 108,000 | ...... | 27 04 | 88,000 | 23,000 |
| Cigar boxes | 103,200 | ...... | 93 08 | ......... | 103,200 |
| Pumps | 3,800 | ...... | 39 21 | 3,800 | .......... |
| Woodenware and novelties | 406,000 | ...... | 42 53 | 210,000 | 196,000 |
| Handles | 336,500 | ...... | 17 80 | 232,500 | 104,000 |
| Laundry appliances | 9,000 | ...... | 40 00 | 5,000 | 4,000 |
| Electrical machinery and apparatus | 330,500 | ...... | 40 54 | 145,500 | 185,000 |
| Machinery construction | 299,700 | ...... | 54 39 | 237,700 | 62,000 |
| Patterns and flasks | 100,000 | ...... | 35 00 | 100,000 | .......... |
| Toys | 1,000 | ...... | 19 00 | 1,000 | .......... |
| Whips, canes and umbrella sticks | 20,000 | ...... | 65 00 | ......... | 20,000 |
| Printing material | 200,000 | ...... | 40 00 | ......... | 200,000 |
| Gates and fencing | 100,000 | ...... | 30 00 | ......... | 100,000 |
| Signs and supplies | 5,000 | ...... | 50 00 | 5,000 | .......... |
| Playground equipment | 2,000 | ...... | 60 00 | 2,000 | .......... |
| Aeroplanes | 3,500 | ...... | 42 29 | 1,500 | 2,000 |
| Boxes and crates, packing | 220,500 | ...... | ...... | ......... | .......... |
| Total | 130,132,391 | *97.96 | ...... | 30,215,177 | 92,873,000 |

* All others (less than 500 M) = 2.04 per cent.

TABLE 53 — SHORT LEAF PINE

| Name of Industry | Quantity used annually | | Average cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Boxes and crates, packing | 47,060,000 | 36.16 | $24 32 | ......... | 47,060,000 |
| Planing mill products | 29,106,200 | 22.44 | 29 17 | ......... | 29,106,200 |
| Car construction | 24,551,800 | 18.86 | 28 51 | ......... | 24,551,800 |
| Sash, doors, blinds and general mill work | 21,105,200 | 16.98 | 28 30 | ......... | 21,105,200 |
| Agricultural implements | 2,911,000 | 2.23 | 37 96 | ......... | 2,911,000 |
| Ship and boat building | 1,626,300 | 1.02 | 29 50 | ......... | 1,626,300 |
| Furniture | 603,000 | 0.46 | 22 40 | ......... | 603,000 |
| Sporting and athletic goods | 592,000 | 0.45 | 37 75 | ......... | 592,000 |
| Dairymen's, poulterers' and apiarists' supplies | 152,000 | ...... | 24 98 | ......... | 152,000 |
| Vehicles and vehicle parts | 253,500 | ...... | 24 62 | ......... | 253,500 |
| Fixtures | 332,000 | ...... | 32 12 | ......... | 332,000 |
| Caskets and coffins | 240,000 | ...... | 21 00 | ......... | 240,000 |
| Refrigerators and kitchen cabinets | 105,000 | ...... | 30 43 | ......... | 105,000 |
| Tanks and silos | 28,400 | ...... | 28 20 | ......... | 28,400 |
| Woodenware and novelties | 220,000 | ...... | 16 18 | ......... | 220,000 |
| Picture frames and mouldings | 25,000 | ...... | 35 00 | ......... | 25,000 |
| Laundry appliances | 21,600 | ...... | 25 46 | ......... | 21,600 |
| Electrical machinery and apparatus | 132,000 | ...... | 28 00 | ......... | 132,000 |
| Machine construction | 350,000 | ...... | 29 44 | ......... | 350,000 |
| Patterns and flasks | 24,000 | ...... | 26 63 | ......... | 24,000 |
| Elevators | 92,500 | ...... | 24 95 | ......... | 92,500 |
| Plumbers' woodwork | 200,000 | ...... | 28 75 | ......... | 200,000 |
| Printing material | 200,000 | ...... | 15 00 | ......... | 200,000 |
| Gates and fences | 200,000 | ...... | 25 00 | ......... | 200,000 |
| Total | 130,134,500 | *96.60 | ...... | ......... | 130,134,500 |

* All others (less than 500 M) = 3.40 per cent.

TABLE 54 — SUGAR MAPLE

| Name of Industry | Quantity used annually: Feet b. m. | Quantity used annually: Per cent | Average cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| Boot and shoe findings | 21,196,000 | 23.50 | $24 15 | 18,096,000 | 3,100,000 |
| Planing mill products | 14,929,500 | 16.55 | 25 28 | 10,900,500 | 4,029,200 |
| Musical instruments | 10,445,900 | 11.56 | 35 28 | 548,900 | 845,000 |
| Furniture | 8,391,900 | 9.25 | 28 62 | 5,117,400 | 3,234,500 |
| Agricultural implements | 7,970,750 | 8.83 | 28 84 | 2,699,500 | 5,271,250 |
| Sash, doors, blinds and general mill work | 6,383,200 | 7.07 | 27 22 | 2,879,200 | 3,504,000 |
| Chairs | 2,639,300 | 2.92 | 23 86 | 1,877,800 | 761,500 |
| Baskets and fruit packages | 2,480,400 | 2.75 | 17 60 | 2,265,400 | 215,000 |
| Fixtures | 2,215,000 | 2.45 | 28 19 | 112,000 | 2,103,000 |
| Vehicles and vehicle parts | 1,984,400 | 2.18 | 31 61 | 1,085,900 | 898,500 |
| Handles | 1,418,000 | 1.57 | 18 57 | 1,350,000 | 68,000 |
| Boxes and crates, packing | 1,689,400 | 1.85 | 16 77 | 1,650,900 | 38,500 |
| Toys | 960,500 | 1.06 | 23 12 | 710,500 | 250,000 |
| Professional and scientific instruments | 862,000 | .95 | 38 39 | 247,000 | 615,000 |
| Sporting and athletic goods | 851,000 | .94 | 41 02 | 274,000 | 577,000 |
| Laundry appliances | 819,000 | .90 | 23 44 | 269,000 | 550,000 |
| Miscellaneous | 706,000 | .77 | 50 04 | ......... | 706,000 |
| Machine construction | 593,300 | .65 | 29 56 | 500,100 | 93,200 |
| Pumps | 506,000 | .56 | 21 97 | 6,000 | 500,000 |
| Car construction | 30,200 | ...... | 61 92 | 2,500 | 27,700 |
| Dairymen's, poulterers' and apiarists' supplies | 347,200 | ...... | 27 87 | 200,200 | 147,000 |
| Ship and boat building | 422,500 | ...... | 36 33 | 347,500 | 75,000 |
| Refrigerators and kitchen cabinets | 378,500 | ...... | 23 95 | 28,500 | 350,000 |
| Tanks and silos | 135,000 | ...... | 17 41 | 75,000 | 60,000 |
| Woodenware and novelties | 317,500 | ...... | 18 92 | 297,500 | 20,000 |
| Picture frames and mouldings | 140,400 | ...... | 48 25 | 45,400 | 95,000 |
| Electrical machinery and apparatus | 112,300 | ...... | 28 00 | 62,300 | 50,000 |
| Patterns and flasks | 15,000 | ...... | 36 93 | 15,000 | .......... |
| Elevators | 398,000 | ...... | 43 15 | 398,000 | .......... |
| Whips, canes and umbrella sticks | 20,000 | ...... | 50 00 | ......... | .......... |
| Plumber's woodwork | 56,000 | ...... | 50 00 | 31,000 | 25,000 |
| Printing material | 50,000 | ...... | 45 00 | ......... | 50,000 |
| Shade and map rollers | 12,500 | ...... | 20 40 | 12,500 | .......... |
| Shuttles, spools and bobbins | 150,000 | ...... | 25 00 | 80,000 | 70,000 |
| Pulleys and conveyors | 400,000 | ...... | 19 75 | 225,000 | 175,000 |
| Dowels | 1,000 | ...... | 16 00 | 1,000 | .......... |
| Signs and supplies | 1,500 | ...... | 35 00 | 1,500 | .......... |
| Playground equipment | 4,000 | ...... | 55 00 | 4,000 | .......... |
| Total | 90,033,150 | *96.31 | ...... | 52,417,000 | 28,504,350 |

* All others (less than 500 M.) = 3.69 per cent.

TABLE 55 — HEMLOCK

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Planing mill products | 39,437,500 | 48.70 | $19 73 | 29,547,500 | 9,890,000 |
| Sash, doors, blinds and general mill work | 26,436,600 | 31.68 | 20 44 | 11,187,600 | 15,249,000 |
| Boxes and crates, packing | 10,448,900 | 12.58 | 19 51 | 5,427,400 | 5,021,500 |
| Furniture | 1,570,000 | 1.75 | 14 11 | 55,000 | 1,515,000 |
| Car construction | 1,560,000 | 1.74 | 19 38 | 31,500 | 1,245,000 |
| Tanks and silos | 1,190,000 | 1.31 | 24 39 | 380,000 | 810,000 |
| Baskets and fruit packages | 719,000 | .85 | 16 56 | 689,000 | 30,000 |
| Machine construction | 550,000 | .52 | 15 55 | 550,000 | ........ |
| Musical instruments | 26,000 | ...... | 24 00 | ........ | 26,000 |
| Dairymen's, poulterers' and apiarists' supplies | 172,000 | ...... | 18 62 | 170,000 | 2,000 |
| Ship and boat building | 46,000 | ...... | 26 52 | 46,000 | ........ |
| Vehicles and vehicle parts | 24,000 | ...... | 26 33 | 24,000 | ........ |
| Agricultural implements | 328,500 | ...... | 20 26 | 328,500 | ........ |
| Refrigerators and kitchen cabinets | 50,000 | ...... | 20 00 | 50,000 | ........ |
| Electrical machinery and apparatus | 114,000 | ...... | 14 15 | 114,000 | ........ |
| Sporting and athletic goods | 180,600 | ...... | 17 50 | 180,600 | ........ |
| Patterns and flasks | 75,800 | ...... | 15 87 | 15,800 | 60,000 |
| Gates and fencing | 100,000 | ...... | 20 00 | ........ | 100,000 |
| Total | 83,028,900 | *99.13 | ...... | 48,796,900 | 33,948,500 |

* All others (less than 500 M.) = 0.87 per cent.

TABLE 56 — CHESTNUT

| Name of Industry | Quantity used annually | | Average cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Dairymen's, poulterers' and apiarists' supplies | 20,388,100 | 28.6 | $31 66 | 500,000 | 19,988,100 |
| Sash, doors and blinds | 13,324,200 | 18.7 | 36 17 | 2,900,500 | 10,423,700 |
| Furniture | 9,752,590 | 13.7 | 23 00 | 1,625,500 | 8,127,090 |
| Caskets and coffins | 9,199,000 | 12.9 | 24 12 | 380,000 | 8,819,000 |
| Planing mill products | 6,170,200 | 8.68 | 31 07 | 3,685,000 | 2,485,200 |
| Boxes and crates, packing | 4,380,250 | 6.16 | 17 40 | 1,612,750 | 2,767,500 |
| Musical instruments | 3,596,000 | 5.06 | 23 42 | 124,000 | 3,472,000 |
| Fixtures | 1,828,100 | 2.57 | 25 84 | 1,275,800 | 552,800 |
| Ship and boat building | 105,800 | ...... | 36 40 | 55,300 | 50,500 |
| Vehicles and vehicle parts | 271,200 | ...... | 16 67 | 270,200 | 1,000 |
| Agricultural implements | 133,000 | ...... | 23 38 | 74,000 | 59,000 |
| Chairs | 486,500 | ...... | 20 76 | 204,500 | 282,000 |
| Professional and scientific instruments | 2,500 | ...... | 35 00 | ......... | 2,500 |
| Baskets and fruit packages | 452,000 | ...... | 16 33 | 448,500 | 3,500 |
| Refrigerators | 85,000 | ...... | 19 24 | 15,000 | 70,000 |
| Woodenware and novelties | 31,000 | ...... | 28 97 | 31,000 | .......... |
| Picture frames and mouldings | 334,250 | ...... | 40 40 | 39,000 | 295,250 |
| Electrical machinery | 100,000 | ...... | 25 45 | 25,000 | 75,000 |
| Sporting and athletic goods | 17,000 | ...... | 45 29 | 10,000 | 7,000 |
| Patterns and flasks | 20,000 | ...... | 25 90 | ......... | 20,000 |
| Toys | 125,000 | ...... | 21 80 | 100,000 | 25,000 |
| Plumbers' woodwork | 1,000 | ...... | 50 00 | ......... | 1,000 |
| Printing material | 250,000 | ...... | 18 00 | 250,000 | .......... |
| Brushes and brooms | 1,500 | ...... | 55 00 | 1,500 | .......... |
| Total | 71,067,690 | *91.37 | ...... | 13,627,550 | 57,527,140 |

* All others (less than 500 M.) = 8.63 per cent.

TABLE 57 — LOBLOLLY PINE

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Boxes and crates, packing | 57,845,000 | 81.9 | $19 95 | ......... | 57,845,000 |
| Miscellaneous | 3,850,000 | 5.45 | 20 45 | ......... | 3,850,000 |
| Planing mill products | 3,692,000 | 5.22 | 29 27 | ......... | 3,692,000 |
| Car construction | 1,981,000 | 2.8 | 23 84 | ......... | 1,981,000 |
| Sash, doors and blinds | 1,179,100 | 1.6 | 27 78 | ......... | 1,179,100 |
| Clocks | 926,571 | 1.3 | 19 50 | ......... | 926,571 |
| Furniture | 80,000 | ...... | 21 00 | ......... | 80,000 |
| Dairymen's and poulterers' supplies | 160,000 | ...... | 21 00 | ......... | 160,000 |
| Ship and boat building | 75,000 | ...... | 22 00 | ......... | 75,000 |
| Vehicles and vehicle parts | 60,000 | ...... | 33 50 | ......... | 60,000 |
| Agricultural implements | 30,000 | ...... | 28 00 | ......... | 30,000 |
| Fixtures | 470,000 | ...... | 26 97 | ......... | 470,000 |
| Refrigerators | 100,000 | ...... | 14 00 | ......... | 100,000 |
| Tanks and silos | 30,000 | ...... | 25 00 | ......... | 30,000 |
| Woodenware and novelties | 19,000 | ...... | 30 50 | ......... | 19,000 |
| Machine construction | 99,000 | ...... | 20 80 | ......... | 99,000 |
| Total | 70,596,671 | *98.27 | ...... | ......... | 70,596,671 |

* All others (less than 500 M.) = 1.73 per cent.

TABLE 58 — LONG LEAF PINE

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Ship and boat building | 19,354,500 | 30.06 | $33 97 | ......... | 19,354,500 |
| Planing mill products | 14,546,600 | 22.75 | 30 86 | ......... | 14,546,600 |
| Sash, doors, blinds and general mill work | 12,650,615 | 19.63 | 32 22 | ......... | 12,650,615 |
| Car construction | 11,638,500 | 18.08 | 30 61 | ......... | 11,638,500 |
| Agricultural implements | 3,371,200 | 5.24 | 36 97 | ......... | 3,371,200 |
| Miscellaneous | 1,000,000 | 1.55 | 35 00 | ......... | 1,000,000 |
| Boxes and crates, packing | 568,000 | .88 | 23 87 | ......... | 568,000 |
| Furniture | 4,000 | ...... | 45 00 | ......... | 4,000 |
| Musical instruments | 5,000 | ...... | 45 00 | ......... | 5,000 |
| Dairymen's, poulterers' and apiarists' supplies | 12,000 | ...... | 42 00 | ......... | 12,000 |
| Vehicles and vehicle parts | 419,300 | ...... | 35 43 | ......... | 419,300 |
| Fixtures | 28,100 | ...... | 43 45 | ......... | 28,100 |
| Professional and scientific instruments | 22,600 | ...... | 44 47 | ......... | 22,600 |
| Refrigerators and kitchen cabinets | 24,000 | ...... | 40 00 | ......... | 24,000 |
| Tanks and silos | 408,700 | ...... | 28 67 | ......... | 408,700 |
| Woodenware and novelties | 10,000 | ...... | 37 50 | ......... | 10,000 |
| Laundry appliances | 19,900 | ...... | 53 17 | ......... | 19,900 |
| Electrical machinery and apparatus | 25,000 | ...... | 40 00 | ......... | 25,000 |
| Machine construction | 176,700 | ...... | 36 32 | ......... | 176,700 |
| Sporting and athletic goods | 15,000 | ...... | 42 00 | ......... | 15,000 |
| Elevators | 24,000 | ...... | 40 00 | ......... | 24,000 |
| Playground equipment | 45,000 | ...... | 40 00 | ......... | 45,000 |
| Total | 64,368,715 | *98.21 | ...... | ......... | 64,368,715 |

* All others (less than 500 M.) = 1.79 per cent.

TABLE 59 — CYPRESS, BALD

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Sash, doors, blinds and general mill work | 29,617,270 | 49.10 | $37 60 | ......... | 29,617,270 |
| Planing mill products | 17,199,250 | 28.51 | 45 15 | ......... | 17,199,250 |
| Boxes and crates, packing | 5,524,900 | 9.16 | 37 75 | ......... | 5,524,900 |
| Tanks and silos | 2,580,550 | 4.21 | 40 45 | ......... | 2,580,550 |
| Laundry appliances | 2,032,300 | 3.38 | 37 17 | ......... | 2,032,300 |
| Furniture | 735,300 | 1.21 | 31 95 | ......... | 735,300 |
| Pumps | 500,000 | 0.82 | 22 50 | ......... | 500,000 |
| Car construction | 10,000 | ...... | 40 00 | ......... | 10,000 |
| Musical instruments | 2,500 | ...... | 48 00 | ......... | 2,500 |
| Dairymen's, poulterers' and apiarists' supplies | 280,000 | ...... | 44 79 | ......... | 280,000 |
| Ship and boat building | 380,800 | ...... | 50 91 | ......... | 380,800 |
| Vehicles and vehicle parts | 37,000 | ...... | 55 27 | ......... | 37,000 |
| Agricultural implements | 168,000 | ...... | 39 19 | ......... | 168,000 |
| Fixtures | 163,500 | ...... | 38 36 | ......... | 163,500 |
| Professional and scientific instruments | 2,000 | ...... | 55 00 | ......... | 2,000 |
| Caskets and coffins | 425,000 | ...... | 48 11 | ......... | 425,000 |
| Refrigerators and kitchen cabinets | 150,000 | ...... | 46 67 | ......... | 150,000 |
| Picture frames and mouldings | 271,000 | ...... | 34 12 | ......... | 271,000 |
| Electrical machinery and apparatus | 47,000 | ...... | 50 00 | ......... | 47,000 |
| Machine construction | 155,000 | ...... | 59 77 | ......... | 155,000 |
| Pulleys and conveyors | 3,000 | ...... | 59 00 | ......... | 3,000 |
| Gates and fencing | 30,000 | ...... | 48 00 | ......... | 30,000 |
| Total | 60,314,370 | *96.39 | ...... | ......... | 60,314,370 |

* All others (less than 500 M.) = 3.61 per cent.

TABLE 60 — RED OAK

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Car construction | 11,077,000 | 18.66 | $26 59 | 641,000 | 10,436,000 |
| Furniture | 10,017,200 | 16.73 | 42 47 | 3,317,800 | 6,699,400 |
| Sash, doors, blinds and general mill work | 9,609,400 | 16.03 | 45 76 | 3,597,300 | 6,012,100 |
| Planing mill products | 7,677,100 | 12.83 | 36 03 | 4,180,600 | 3,496,500 |
| Chairs | 4,080,500 | 6.83 | 39 69 | 1,608,000 | 2,472,500 |
| Boxes and crates, packing | 3,349,500 | 5.59 | 15 13 | 149,500 | 3,200,000 |
| Vehicles and vehicle parts | 2,586,200 | 4.31 | 48 07 | 696,200 | 1,890,000 |
| Musical instruments | 2,168,000 | 3.62 | 63 59 | 401,250 | 1,766,500 |
| Refrigerators | 1,935,500 | 3.23 | 34 73 | 145,500 | 1,790,000 |
| Fixtures | 1,898,500 | 3.17 | 44 57 | 695,000 | 1,203,500 |
| Ship and boat building | 1,280,400 | 2.13 | 45 76 | 272,000 | 1,007,500 |
| Agricultural implements | 655,500 | 1.09 | 41 02 | 494,500 | 161,000 |
| Sporting and athletic goods | 525,000 | .89 | 69 05 | 25,000 | 200,000 |
| Plumbers' woodwork | 518,000 | .88 | 35 07 | 233,000 | 285,000 |
| Dairymen's, poulterers' and apiarists' supplies | 70,000 | ...... | 27 50 | 70,000 | .......... |
| Professional and scientific instruments | 53,500 | ...... | 38 84 | 11,000 | 42,500 |
| Caskets and coffins | 481,000 | ...... | 45 72 | 16,000 | 465,000 |
| Baskets and fruit packages | 87,300 | ...... | 21 92 | 82,300 | 5,000 |
| Pumps | 2,000 | ...... | 40 00 | 2,000 | .......... |
| Woodenware and novelties | 145,000 | ...... | 44 66 | 58,000 | 87,000 |
| Picture frames and mouldings | 365,500 | ...... | 47 40 | 120,000 | 245,500 |
| Laundry appliances | 11,000 | ...... | 40 00 | 5,000 | 6,000 |
| Electrical machinery and apparatus | 210,000 | ...... | 35 86 | 60,000 | 150,000 |
| Machine construction | 256,500 | ...... | 52 18 | 194,500 | 62,000 |
| Patterns and flasks | 3,000 | ...... | 55 00 | .......... | 3,000 |
| Toys | 100,000 | ...... | 30 00 | 100,000 | .......... |
| Clocks | 150,000 | ...... | 30 00 | .......... | 150,000 |
| Elevators | 150,000 | ...... | 40 00 | 50,000 | 100,000 |
| Gates and fencing | 100,700 | ...... | 29 92 | 700 | 100,000 |
| Signs and supplies | 5,000 | ...... | 45 00 | 5,000 | .......... |
| Miscellaneous | 250,000 | ...... | 40 00 | .......... | 250,000 |
| Tanks and silos | 50,000 | ...... | 25 00 | 50,000 | .......... |
| Total | 59,718,300 | *95.99 | ...... | .......... | 42,286,000 |

* All others (less than 500 M.) = 4.01 per cent.

TABLE 61 — YELLOW POPLAR

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Sash, doors and blinds | 10,908,750 | 19.0 | $42 75 | 1,283,500 | 9,625,250 |
| Musical instruments | 9,933,300 | 17.42 | 48 86 | 1,011,200 | 8,922,100 |
| Boxes and crates, packing | 9,543,400 | 16.7 | 24 72 | 88,500 | 9,454,900 |
| Furniture | 6,056,780 | 10.6 | 38 76 | 477,500 | 5,579,280 |
| Planing mill | 5,100,500 | 8.9 | 39 94 | 172,500 | 4,938,000 |
| Fixtures | 3,023,250 | 5.3 | 43 27 | 233,000 | 2,790,250 |
| Vehicles and vehicle parts | 2,701,900 | 4.7 | 62 90 | 488,600 | 2,213,300 |
| Dairymen's, poulterers' and apiarists' supplies | 1,725,200 | 3.2 | 29 89 | 125,000 | 1,600,200 |
| Caskets and coffins | 979,000 | 1.7 | 35 25 | ......... | 979,000 |
| Car construction | 896,800 | 1.5 | 57 52 | 10,000 | 886,800 |
| Picture frames and mouldings | 749,250 | 1.3 | 42 67 | 102,000 | 647,250 |
| Miscellaneous | 715,000 | 1.2 | 34 91 | ......... | 715,000 |
| Agricultural implements | 673,700 | 1.18 | 37 87 | 50,500 | 623,200 |
| Refrigerators | 667,000 | 1.1 | 40 53 | 25,000 | 642,000 |
| Excelsior | 603.000 | 1.05 | 20 31 | 603,000 | .......... |
| Ship and boat building | 97,000 | ...... | 45 88 | ......... | 97,000 |
| Chairs | 65,000 | ...... | 27 28 | ......... | 65,000 |
| Professional and scientific instruments | 475,000 | ...... | 47 37 | ......... | 475,000 |
| Baskets and fruit packages | 123,000 | ...... | 34 68 | 36,500 | 86,500 |
| Cigar boxes | 264,000 | ...... | 41 63 | ......... | 264,000 |
| Woodenware and novelties | 145,500 | ...... | 39 90 | 26,500 | 119,000 |
| Laundry appliances | 311,200 | ...... | 44 89 | 7,500 | 303,700 |
| Electrical machinery | 230,000 | ...... | 34 67 | ......... | 230,000 |
| Machine construction | 476,000 | ...... | 43 34 | 175,000 | 301,000 |
| Sporting and athletic goods | 351,200 | ...... | 58 66 | 300,000 | 51,200 |
| Patterns and flasks | 8,350 | ...... | 100 00 | ......... | 8,350 |
| Toys | 38,000 | ...... | 28 63 | ......... | 38,000 |
| Elevators | 5,000 | ...... | 45 00 | ......... | 5,000 |
| Plumbers' woodwork | 10,000 | ...... | 90 00 | ......... | 10,000 |
| Brushes and brooms | 10,600 | ...... | 31 89 | 600 | 10,000 |
| Shuttles, spools, etc | 50,000 | ...... | 30 00 | ......... | 50,000 |
| Playground equipment | 35,000 | ...... | 51 71 | 15,000 | 20,000 |
| Aeroplanes | 4,200 | ...... | 40 00 | 1,000 | 3,200 |
| Total | 56,975,880 | *94.35 | ...... | 5,232,400 | 51,753,480 |

* All others (less than 500 M.) = 5.65 per cent.

Small squares and pieces saved from hardwood slabs, edgings and defective material formerly wasted and now utilized for chair rounds, furniture parts, novelties, dowels, etc. The forest products of the Adirondack region are probably utilized more closely than those of any other region in this country. Photograph taken at a large hardwood operation at McKeever. Photograph by NELSON C. BROWN.

TABLE 62 — BASSWOOD

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Boxes and crates, packing.... | 10,289,900 | 18.0 | $25 65 | 4,369,000 | 5,920,900 |
| Planing mill products........ | 7,569,900 | 13.2 | 25 29 | 5,507,400 | 2,512,500 |
| Dairymen's, poulterers' and apiarists' supplies......... | 6,104,000 | 10.7 | 22 53 | 4,082,000 | 2,022,000 |
| Furniture.................. | 5,326,200 | 9.2 | 25 16 | 1,880,200 | 3,446,000 |
| Sash, doors, blinds and general mill work................ | 5,027,400 | 8.8 | 27 47 | 2,537,000 | 2,490,400 |
| Musical instruments......... | 3,513,600 | 6.11 | 37 64 | 1,328,600 | 2,185,000 |
| Excelsior.................. | 2,080,000 | 3.47 | 18 03 | 1,980,000 | 100,000 |
| Trunks and valises.......... | 2,260,500 | 3.09 | 33 32 | 1,085,500 | 1,175,000 |
| Professional and scientific instruments................ | 1,748,200 | 3,06 | 34 29 | 1,069,200 | 679,000 |
| Woodenware and novelties... | 1,721,200 | 3.00 | 30 13 | 1,451,200 | 270,000 |
| Vehicles and vehicle parts.... | 1,622,450 | 2.84 | 31 67 | 957,150 | 665,300 |
| Baskets and fruit packages... | 1,426,400 | 2.53 | 19 09 | 1,276,400 | 150,000 |
| Toys....................... | 1,412,500 | 2.47 | 31 41 | 762,500 | 650,000 |
| Agricultural implements..... | 1,367,000 | 2.3 | 28 60 | 1,127,000 | 240,000 |
| Boot and shoe findings....... | 1,241,000 | 2.17 | 36 46 | 1,094,000 | 147,000 |
| Picture frames and mouldings | 1,137,500 | 1.99 | 39 44 | 174,000 | 963,500 |
| Laundry appliances......... | 1,010,670 | 1.77 | 24 02 | 905,000 | 105,670 |
| Car construction............ | 11,700 | ...... | 49 40 | 3,700 | 8,000 |
| Ship and boat building...... | 156,000 | ...... | 25 18 | 121,000 | 35,000 |
| Chairs..................... | 418,000 | ...... | 23 91 | 260,000 | 158,000 |
| Fixtures................... | 201,000 | ...... | 36 42 | 76,000 | 125,000 |
| Caskets and coffins......... | 149,000 | ...... | 35 64 | 27,000 | 122,000 |
| Refrigerators.............. | 95,000 | ...... | 24 72 | 35,000 | 60,000 |
| Tanks and silos............ | 5,000 | ...... | 40 00 | ......... | 5,000 |
| Cigar boxes................ | 2,000 | ...... | 40 00 | ......... | 2,000 |
| Handles.................... | 37,000 | ...... | 24 32 | 37,000 | .......... |
| Electrical machinery and apparatus................. | 84,000 | ...... | 32 14 | 84,000 | .......... |
| Machine construction........ | 260,500 | ...... | 26 72 | 210,500 | 50,000 |
| Sporting and athletic goods... | 60,600 | ...... | 36 37 | 12,000 | 48,600 |
| Patterns and flasks.......... | 105,500 | ...... | 34 47 | 105,500 | .......... |
| Clocks..................... | 10,000 | ...... | 30 00 | ......... | 150,000 |
| Elevators.................. | 10,000 | ...... | 28 00 | 10,000 | .......... |
| Whips, canes and umbrellas.. | 20,000 | ...... | 40 00 | ......... | 20,000 |
| Printing material........... | 290,500 | ...... | 30 00 | 290,500 | .......... |
| Shade and map rollers....... | 15,000 | ...... | 18 00 | 15,000 | .......... |
| Brushes and brooms......... | 138,000 | ...... | 20 29 | 138,000 | .......... |
| Dowels..................... | 15,000 | ...... | 19 00 | 15,000 | .......... |
| Miscellaneous.............. | 35,000 | ...... | 25 00 | 35,000 | .......... |
| Total.................. | 56,977,220 | *94.7 | ...... | 33,061,350 | 24,505,870 |

* All others (less than 500 M.) = 5.3 per cent.

TABLE 63 — BIRCH

| Name of Industry | Quantity used annually: Feet b. m. | Quantity used annually: Per cent | Average cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| Sash, doors and blinds | 10,695,800 | 24.23 | $35 55 | 5,004,900 | 5,690,900 |
| Furniture | 10,040,382 | 22.74 | 26 34 | 7,937,932 | 2,102,450 |
| Planing mill products | 7,382,100 | 16.72 | 27 36 | 5,021,500 | 2,360,600 |
| Chairs | 2,889,500 | 6.54 | 31 02 | 2,730,500 | 159,000 |
| Musical instruments | 2,791,500 | 6.32 | 30 19 | 2,036,500 | 755,000 |
| Boxes and crates, packing | 1,836,000 | 4.16 | 19 26 | 1,636,000 | 200,000 |
| Vehicles and vehicle parts | 1,455,000 | 3.29 | 37 63 | 696,700 | 758,300 |
| Fixtures | 1,055,500 | 2.39 | 46 61 | 537,500 | 518,000 |
| Handles | 861,000 | 1.9 | 13 77 | 861,000 | .......... |
| Baskets and fruit packages | 714,000 | 1.6 | 18 74 | 702,000 | 12,000 |
| Picture frames and mouldings | 647,000 | 1.4 | 46 33 | 543,500 | 103,500 |
| Shuttles, spools and bobbins | 552,000 | 1.25 | 20 92 | 452,000 | 100,000 |
| Dowels | 546,000 | 1.21 | 40 04 | 546,000 | .......... |
| Car construction | 7,000 | ...... | 61 43 | 1,000 | 6,000 |
| Dairymen's, poulterers' and apiarists' supplies | 26,000 | ...... | 18 00 | 26,000 | .......... |
| Ship and boat building | 135,000 | ...... | 33 33 | 22,500 | 112,500 |
| Agricultural implements | 390,000 | ...... | 30 82 | 380,000 | 10,000 |
| Boot and shoe findings | 91,000 | ...... | 28 16 | 91,000 | .......... |
| Professional and scientific instruments | 57,300 | ...... | 48 43 | 57,300 | .......... |
| Caskets and coffins | 35,000 | ...... | 22 00 | ......... | 35,000 |
| Refrigerators | 168,500 | ...... | 19 85 | 108,500 | 60,000 |
| Woodenware and novelties | 187,500 | ...... | 20 41 | 167,500 | 20,000 |
| Laundry appliances | 203,000 | ...... | 18 06 | 203,000 | .......... |
| Electrical machinery | 220,200 | ...... | 41 29 | 120,200 | 100,000 |
| Machine construction | 3,000 | ...... | 48 33 | 3,000 | .......... |
| Patterns and flasks | 1,000 | ...... | 30 00 | 1,000 | .......... |
| Toys | 100,000 | ...... | 20 00 | 50,000 | 50,000 |
| Clocks | 5,044 | ...... | 55 71 | ......... | 5,044 |
| Elevators | 22,000 | ...... | 33 41 | 22,000 | .......... |
| Whips, canes and umbrella sticks | 25,000 | ...... | 50 00 | ......... | 25,000 |
| Plumbers' woodwork | 216,000 | ...... | 45 58 | 141,000 | 75,000 |
| Printing material | 100,000 | ...... | 42 00 | ......... | 100,000 |
| Brushes and brooms | 463,000 | ...... | 19 26 | 293,000 | 170,000 |
| Pulleys and conveyors | 160,000 | ...... | 40 00 | 60,000 | 100,000 |
| Playground equipment | 30,000 | ...... | 30 00 | 30,000 | .......... |
| Miscellaneous | 25,000 | ...... | 25 00 | 25,000 | .......... |
| Total | 44,136,326 | *93.75 | ...... | 30,548,032 | 13,628,294 |

* All others (less than 500 M.) = 6.25 per cent.

TABLE 64 — BEECH

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Planing mill products | 8,757,400 | 20.55 | $20 24 | 7,602,400 | 1,155,000 |
| Boxes and crates, packing | 7,367,500 | 17.31 | 22 23 | 3,735,000 | 3,632,500 |
| Furniture | 4,958,000 | 11.65 | 19 77 | 3,296,000 | 1,662,825 |
| Baskets and fruit packages | 4,013,500 | 9.43 | 17 93 | 3,164,500 | 849,000 |
| Handles | 3,076,000 | 7.22 | 17 80 | 2,973,000 | 103,000 |
| Sash, doors, blinds and general mill work | 2,271,600 | 5.10 | 23 53 | 1,596,600 | 675,000 |
| Whips, canes and umbrella sticks | 2,035,000 | 4.54 | 23 16 | 2,000,000 | 35,000 |
| Chairs | 1,467.500 | 3.44 | 18 98 | 1,354,500 | 113,000 |
| Agricultural implements | 1,322,000 | 3.10 | 25 33 | 617,200 | 447,000 |
| Miscellaneous | 1,035,000 | 2.43 | 21 69 | 135,000 | 900,000 |
| Woodenware and novelties | 1,014,000 | 2.38 | 15 59 | 1,014,000 | .......... |
| Vehicles and vehicle parts | 718,000 | 1.68 | 18 94 | 668,000 | 50,000 |
| Laundry appliances | 575,000 | 1.33 | 20 13 | 225,000 | 350,000 |
| Dairymen's, poulterers' and apiarists' supplies | 663,600 | 1.55 | 19 12 | 539,600 | 124,000 |
| Brushes and brooms | 565,000 | 1.32 | 20 33 | 460,000 | 105,000 |
| Musical instruments | 617,000 | 1.45 | 29 83 | 317,000 | 300,000 |
| Car construction | 457,000 | ...... | 18 00 | ......... | 457,000 |
| Ship and boat building | 65,000 | ...... | 25 00 | 65,000 | .......... |
| Boot and shoe findings | 60,000 | ...... | 16 00 | 60,000 | .......... |
| Fixtures | 65,000 | ...... | 27 00 | ......... | 65,000 |
| Professional and scientific instruments | 188,000 | ...... | 25 35 | 188,000 | .......... |
| Tanks and silos | 125,000 | ...... | 16 00 | 60,000 | 65,000 |
| Pumps | 2,500 | ...... | 19 20 | 2,500 | .......... |
| Electrical machinery and apparatus | 375,000 | ...... | 16 40 | 25,000 | 350,000 |
| Machine construction | 61,000 | ...... | 18 92 | 57,000 | 4,000 |
| Sporting and athletic goods | 100,000 | ...... | 14 50 | 100,000 | .......... |
| Patterns and flasks | 500 | ...... | 50 00 | 500 | .......... |
| Clocks | 9,714 | ...... | 30 47 | ......... | 9,714 |
| Printing material | 25,000 | ...... | 35 00 | 25,000 | .......... |
| Shade and map rollers | 50,000 | ...... | 16 00 | 50,000 | .......... |
| Shuttles, spools and bobbins | 200,000 | ...... | 20 92 | 200,000 | .......... |
| Pulleys and conveyors | 50,000 | ...... | 25 00 | 50,000 | .......... |
| Dowels | 181,000 | ...... | 18 66 | 131,000 | 50,000 |
| Playground equipment | 76,000 | ...... | 30 40 | 76,000 | .......... |
| Total | 42,546,814 | *95.53 | ...... | 30,617,800 | 11,502,039 |

* All others (less than 500 M.) = 6.47 per cent.

TABLE 65 — RED GUM

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Sash, doors, blinds and general mill work | 23,494,000 | 56.02 | $27 53 | ......... | 23.494,000 |
| Musical instruments | 4,100,200 | 9.7 | 38 42 | ......... | 4,100,200 |
| Furniture | 3,666,825 | 8.7 | 31 06 | ......... | 3,666,825 |
| Boxes and crates, packing | 3,292,700 | 7.8 | 21 13 | ......... | 3,292,700 |
| Planing mill products | 2,244,500 | 5.3 | 34 69 | 50,000 | 2,194,500 |
| Agricultural implements | 1,542,000 | 3.6 | 26 19 | ......... | 1,542,000 |
| Miscellaneous | 1,500,000 | 3.5 | 35 00 | ......... | 1,500,000 |
| Ship and boat building | 100,000 | ...... | 30 00 | 25,000 | 75,000 |
| Chairs | 134,500 | ...... | 28 62 | ......... | 134,500 |
| Fixtures | 168,200 | ...... | 47 78 | ......... | 168,200 |
| Professional and scientific instruments | 75,000 | ...... | 30 00 | ......... | 75,000 |
| Baskets and fruit packages | 163,000 | ...... | 24 56 | ......... | 163,000 |
| Refrigerators and kitchen cabinets | 200,500 | ...... | 40 02 | ......... | 200,500 |
| Picture frames and mouldings | 188,750 | ...... | 42 73 | ......... | 188,750 |
| Electrical machinery and apparatus | 50,000 | ...... | 80 00 | ......... | 50,000 |
| Trunks and valises | 35,000 | ...... | 33 57 | ......... | 35,000 |
| Shade and map rollers | 500,000 | ...... | 25 60 | ......... | 500,000 |
| Brushes and brooms | 30,000 | ...... | 30 00 | ......... | 30,000 |
| Total | 41,485,175 | *94.62 | ...... | 75,000 | 41,410,175 |

* All others (less than 500 M.) = 5.38 per cent.

TABLE 66 — COTTONWOOD

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Excelsior | 11,964,000 | 52.5 | $16 50 | 11,139,000 | 825,000 |
| Boxes and crates, packing | 9,301,000 | 40.8 | 26 82 | 2,395,000 | 6,906,000 |
| Baskets and fruit packages | 528,000 | 2.3 | 17 30 | 528,000 | .......... |
| Planing mill products | 25,000 | ...... | 21 00 | 25,000 | .......... |
| Sash, doors, blinds and general mill work | 15,000 | ...... | 40 00 | 4,700 | 5,800 |
| Musical instruments | 59,000 | ...... | 24 24 | ......... | 59,000 |
| Dairymen's, poulterers' and apiarists' supplies | 40,000 | ...... | 18 88 | ......... | 40,000 |
| Agricultural implements | 255,000 | ...... | 23 67 | ......... | 255,000 |
| Fixtures | 110,000 | ...... | 31 27 | 75,000 | 35,000 |
| Woodenware and novelties | 38,000 | ...... | 16 00 | 38,000 | .......... |
| Picture frames and mouldings | 1,000 | ...... | 22 00 | ......... | 1,000 |
| Machine construction | 1,000 | ...... | 70 00 | ......... | 1,000 |
| Shuttles, spools and bobbins | 5,000 | ...... | 20 00 | 5,000 | .......... |
| Miscellaneous | 300,000 | ...... | ...... | ......... | .......... |
| Vehicles and vehicle parts | 136,000 | ...... | ...... | ......... | .......... |
| Total | 22,778,000 | *95.6 | ...... | 14,209,700 | 8,127,800 |

* All others (less than 500 M.) = 4.4 per cent.

TABLE 67 — ASH

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Vehicles and vehicle parts | 5,128,000 | 29.2 | $45 53 | 2,151,500 | 2,976,500 |
| Refrigerators and kitchen cabinets | 1,798,500 | 10.2 | 28 83 | 859,500 | 939,000 |
| Furniture | 1,423,625 | 8.1 | 27 20 | 959,325 | 464,300 |
| Planing mill products | 1,185,550 | 6.7 | 36 78 | 544,050 | 641,500 |
| Sash, doors, blinds and general mill work | 1,187,000 | 6.7 | 40 83 | 669,000 | 518,000 |
| Agricultural implements | 1,118,200 | 6.3 | 34 76 | 671,200 | 447,000 |
| Woodenware and novelties | 788,500 | 4.5 | 32 06 | 633,500 | 155,000 |
| Miscellaneous | 800,000 | 4.5 | 40 00 | ......... | 800,000 |
| Musical instruments | 517,200 | 2.9 | 67 09 | 94,700 | 422,500 |
| Tanks and silos | 500,000 | 2.8 | 25 00 | ......... | 500,000 |
| Boxes and crates, packing | 248,500 | ...... | 19 38 | 173,500 | 75,000 |
| Car construction | 323,500 | ...... | 59 98 | 10,500 | 313,000 |
| Dairymen's, poulterers' and apiarists' supplies | 293,000 | ...... | 17 90 | 258,000 | 35,000 |
| Ship and boat building | 270,000 | ...... | 59 33 | 115,000 | 155,000 |
| Chairs | 154,000 | ...... | 26 53 | 117,000 | 37,000 |
| Fixtures | 164,050 | ...... | 45 55 | 111,050 | 50,000 |
| Professional and scientific instruments | 6,000 | ...... | 30 00 | 6,000 | .......... |
| Baskets and fruit packages | 128,300 | ...... | 19 40 | 103,300 | 25,000 |
| Pumps | 500 | ...... | 20 00 | 500 | .......... |
| Picture frames and mouldings | 10,000 | ...... | 40 00 | 10,000 | .......... |
| Handles | 466,400 | ...... | 29 91 | 251,400 | 215,000 |
| Electrical machinery and apparatus | 40,000 | ...... | 41 25 | 15,000 | 25,000 |
| Machine construction | 268,000 | ...... | 51 42 | 166,000 | 102,000 |
| Sporting and athletic goods | 61,000 | ...... | 26 48 | 61,000 | .......... |
| Trunks and valises | 70,000 | ...... | 50 00 | ......... | 70,000 |
| Toys | 232,000 | ...... | 25 78 | 212,000 | 20,000 |
| Elevators | 16,200 | ...... | 37 47 | 3,000 | 13,200 |
| Whips, canes and umbrella sticks | 30,000 | ...... | 60 00 | ......... | 30,000 |
| Plumbers' woodwork | 96,000 | ...... | 33 54 | 90,000 | 6,000 |
| Shade and map rollers | 45,000 | ...... | 35 00 | 45,000 | .......... |
| Pulleys and conveyors | 150,000 | ...... | 50 00 | ......... | 150,000 |
| Gates and fencing | 700 | ...... | 18 00 | 700 | .......... |
| Playground equipment | 5,000 | ...... | 28 00 | ......... | 5,000 |
| Aeroplanes | 6,500 | ...... | 20 70 | 4,500 | 2,000 |
| Patterns and flasks | 25,000 | ...... | ...... | ......... | .......... |
| Total | 17,556,225 | *81.9 | ...... | 8,336,225 | 9,192,000 |

* All others (less than 500 M.) = 18.1 per cent.

TABLE 68 — ELM

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Boxes and crates, packing.... | 6,862,500 | 39.6 | $33 62 | 1,354,000 | 5,508,500 |
| Baskets and fruit packages... | 2,260,550 | 10.3 | 17 95 | 2,036,550 | 224,000 |
| Dairymen's, poulterers' and apiarists' supplies.......... | 1,843,600 | 10.0 | 20 28 | 125,000 | 1,600,200 |
| Musical instruments.......... | 1,090,000 | 6.2 | ...... | .......... | .......... |
| Agricultural implements..... | 833,000 | 4.8 | 27 72 | 427,000 | 406,000 |
| Planing mill products......... | 779,600 | 4.5 | 18 55 | 779,600 | .......... |
| Sash, doors, blinds and general mill work................ | 695,300 | 4.0 | 20 77 | 673,300 | 22,000 |
| Fixtures.................. | 723,000 | 4.0 | 36 78 | 23,000 | 700,000 |
| Furniture.................. | 283,200 | ...... | 25 16 | 175,200 | 108,000 |
| Ship and boat building...... | 50,600 | ...... | 23 50 | 50,600 | .......... |
| Vehicles and vehicle parts.... | 441,950 | ...... | 25 39 | 285,150 | 156,800 |
| Chairs..................... | 333,500 | ...... | 27 68 | 123,000 | 210,500 |
| Refrigerators............... | 34,700 | ...... | 21 01 | 34,700 | .......... |
| Cigar boxes................ | 112,500 | ...... | 39 24 | .......... | 112,500 |
| Woodenware and novelties... | 109,000 | ...... | 18 40 | 109,000 | .......... |
| Handles.................. | 30,000 | ...... | 18 00 | 30,000 | .......... |
| Laundry appliances......... | 150,000 | ...... | 40 00 | .......... | 150,000 |
| Machine construction........ | 267,000 | ...... | 29 76 | 234,000 | 33,000 |
| Sporting and athletic goods... | 5,000 | ...... | 30 00 | 5,000 | .......... |
| Trunks and valises.......... | 340,000 | ...... | 34 41 | 50,000 | 290,000 |
| Toys...................... | 15,500 | ...... | 23 23 | 15,500 | .......... |
| Brushes and brooms......... | 50,000 | ...... | 25 00 | 30,000 | 20,000 |
| Total................. | 17,310,500 | *83.4 | ...... | 6,560,600 | 9,541,500 |

* All others (less than 500 M.) = 16.6 per cent.

TABLE 69 — RED CEDAR

| Name of Industry | Quantity used annually | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Professional and scientific instruments | 15,750,000 | 93.7 | $37 55 | ......... | 15,750,000 |
| Planing mill products | 318,000 | ...... | 23 85 | ......... | 318,000 |
| Sash, doors, blinds and general mill work | 129,200 | ...... | 44 17 | 2,000 | 127,200 |
| Furniture | 149,000 | ...... | 60 62 | ......... | 149,000 |
| Ship and boat building | 227,500 | ...... | 54 68 | ......... | 277,500 |
| Vehicles and vehicle parts | 2,000 | ...... | 25 00 | ......... | 2,000 |
| Chairs | 17,500 | ...... | 58 00 | ......... | 17,500 |
| Fixtures | 875 | ...... | 110 00 | ......... | 875 |
| Caskets and coffins | 85,000 | ...... | 52 06 | ......... | 85,000 |
| Tanks and silos | 30,000 | ...... | 46 67 | ......... | 30,000 |
| Woodenware and novelties | 500 | ...... | 25 00 | 500 | .......... |
| Whips, canes and umbrella sticks | 2,000 | ...... | 50 00 | ......... | 2,000 |
| Total | 16,711,575 | *93.7 | ...... | 2,500 | 16,759,075 |

* All others (less than 500 M.) = 6.3 per cent.

TABLE 70 — NORWAY PINE

| Name of Industry | Quantity used annually | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Car construction | 5,250,000 | 42.1 | $24 76 | ......... | 5,250,000 |
| Planing mill products | 3,215,800 | 25.8 | 21 76 | 40,000 | 3,175,800 |
| Boxes and crates, packing | 1,975,000 | 15.9 | 17 29 | ......... | 1,975,000 |
| Tanks and silos | 950,000 | 7.7 | 29 37 | ......... | 950,000 |
| Sash, doors, blinds and general mill work | 772,500 | 6.2 | 20 32 | ......... | 772,500 |
| Ship and boat building | 5,000 | ...... | 25 00 | ......... | 5,000 |
| Refrigerators and kitchen cabinets | 25,000 | ...... | 25 00 | ......... | 25,000 |
| Woodenware and novelties | 75,000 | ...... | 44 00 | ......... | 75,000 |
| Electrical machinery and apparatus | 50,000 | ...... | 20 00 | 50,000 | .......... |
| Playground equipment | 7,000 | ...... | 40 00 | ......... | 7,000 |
| Vehicles and vehicle parts | 5,000 | ...... | 18 00 | ......... | 5,000 |
| Agricultural implements | 40,000 | ...... | 32 00 | ......... | 40,000 |
| Baskets and fruit packages | 50,000 | ...... | 22 00 | 50,000 | .......... |
| Total | 12,420,300 | *96.7 | ...... | 140,000 | 12,280,300 |

* All others (less than 500 M.) = 3.3 per cent.

TABLE 71 — MAHOGANY

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Furniture | 3,608,027 | 32.1 | $128 46 | ......... | 3,608,027 |
| Musical instruments | 2,934,200 | 26.1 | 149 58 | ......... | 2,934,200 |
| Ship and boat building | 225,400 | 21.0 | 160 10 | ......... | 225,400 |
| Sash, doors, blinds and general mill work | 1,172,697 | 10.4 | 149 97 | ......... | 1,172,697 |
| Fixtures | 1,056,800 | 9.4 | 138 56 | ......... | 1,056,800 |
| Chairs | 844,900 | 7.5 | 121 18 | ......... | 844,900 |
| Caskets and coffins | 510,000 | 4.5 | 134 27 | ......... | 510,000 |
| Planing mill products | 238,000 | 2.1 | 151 89 | ......... | 238,000 |
| Cigar boxes | 161,200 | 1.4 | 86 79 | ......... | 161,200 |
| Car construction | 93,300 | ...... | 123 12 | ......... | 93,300 |
| Professional and scientific instruments | 11,000 | ...... | 120 64 | ......... | 11,000 |
| Refrigerators and kitchen cabinets | 1,000 | ...... | 100 00 | ......... | 1,000 |
| Woodenware and novelties | 1,500 | ...... | 170 00 | ......... | 1,500 |
| Picture frames and mouldings | 72,450 | ...... | 155 91 | ......... | 72,450 |
| Electrical machinery and apparatus | 33,500 | ...... | 205 01 | ......... | 33,500 |
| Sporting and athletic goods | 50,000 | ...... | 200 00 | ......... | 50,000 |
| Patterns and flasks | 21,050 | ...... | 16 78 | ......... | 21,050 |
| Clocks | 28,196 | ...... | 104 77 | ......... | 28,196 |
| Whips, canes and umbrella sticks | 15,000 | ...... | 300 00 | ......... | 15,000 |
| Printing material | 25,000 | ...... | 225 00 | ......... | 25,000 |
| Brushes and brooms | 15,000 | ...... | 266 67 | ......... | 15,000 |
| Vehicles and vehicle parts | 90,500 | ...... | 138 74 | ......... | 90,500 |
| Total | 11,208,720 | *82.5 | ...... | ......... | 11,208,720 |

* All others (less than 100 M.) = 17.5 per cent.

Table 72 — Silver Maple

| Name of Industry | Quantity used annually | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Sash, doors, blinds and general mill work | 1,432,000 | 15.9 | $27 78 | 582,000 | 850,000 |
| Musical instruments | 13,939,000 | 15.5 | ...... | ......... | ........... |
| Baskets and fruit packages | 1,394,500 | 15.4 | 18 53 | 940,500 | 454,000 |
| Furniture | 1,335,500 | 14.9 | 32 32 | 399,000 | 936,500 |
| Chairs | 1,177,000 | 12.0 | 27 16 | 477,000 | 600,000 |
| Boxes and crates, packing | 771,000 | 8.6 | 17 35 | 508,500 | 262,500 |
| Pumps | 550,000 | 6.1 | 25 00 | 275,000 | 275,000 |
| Dairymen's, poulterers' and apiarists supplies | 390,500 | 4.3 | 21 72 | 372,500 | 18,000 |
| Machine construction | 167,000 | ...... | 35 00 | 134,000 | 33,000 |
| Planing mill products | 26,000 | ...... | 24 69 | 26,000 | .......... |
| Ship and boat building | 5,000 | ...... | 28 00 | 5,000 | .......... |
| Vehicles and vehicle parts | 80,000 | ...... | 26 00 | 80,000 | .......... |
| Agricultural implements | 23,250 | ...... | 19 44 | 19,000 | 4,250 |
| Boot and shoe findings | 150,000 | ...... | 12 50 | 153,000 | .......... |
| Professional and scientific instruments | 40,000 | ...... | 31 25 | 25,000 | 150,000 |
| Refrigerators and kitchen cabinets | 60,000 | ...... | 23 00 | ......... | 60,000 |
| Woodenware and novelties | 20,000 | ...... | 25 00 | ......... | 20,000 |
| Handles | 10,000 | ...... | 15 00 | 10,000 | .......... |
| Elevators | 30,000 | ...... | 24 00 | 30,000 | .......... |
| Brushes and brooms | 5,000 | ...... | 24 00 | 5,000 | .......... |
| Total | 21,605,750 | *92.7 | ...... | 4,041,500 | 3,663,250 |

* All others (less than 300 M.) = 7.3 per cent.

TABLE 73 — HICKORY

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Vehicles and vehicle parts.... | 6,874,350 | 78.9 | $44 00 | 1,429,250 | 5,445,100 |
| Woodenware and novelties... | 568,500 | 6.4 | 43 24 | 408,500 | 160,000 |
| Agricultural implements..... | 315,000 | ...... | 41 70 | 39,000 | 276,000 |
| Baskets and fruit packages... | 230,200 | 2.6 | 18 18 | 230,200 | .......... |
| Handles.................... | 204,150 | 2.3 | 39 57 | ......... | .......... |
| Refrigerators and kitchen cabinets ..................... | 150,000 | 1.7 | 50 00 | 50,000 | 100,000 |
| Planing mill products........ | 28,800 | ...... | 34 48 | 28,800 | .......... |
| Sash, doors, blinds and general mill work................ | 500 | ...... | 40 00 | 500 | .......... |
| Furniture.................. | 3,500 | ...... | 30 57 | ......... | 3,500 |
| Car construction............ | 28,000 | ...... | 70 00 | 28,000 | .......... |
| Ship and boat building....... | 45,000 | ...... | 43 89 | 10,000 | 35,000 |
| Boot and shoe findings....... | 25,000 | ...... | 20 00 | 25,000 | .......... |
| Professional and scientific instruments................ | 3,000 | ...... | 38 67 | 500 | 2,500 |
| Machine construction........ | 85,000 | ...... | 35 59 | 77,500 | 7,500 |
| Trunks and valises.......... | 80,000 | ...... | 47 50 | ......... | 80,000 |
| Aeroplanes................. | 2,000 | ...... | 40 00 | ......... | 2,000 |
| Chairs..................... | 51,200 | ...... | 31 17 | 50,000 | 1,200 |
| Printing material........... | 20,000 | ...... | 30 00 | 20,000 | .......... |
| Gates and fencing.......... | 600 | ...... | 18 00 | 600 | .......... |
| Whips, canes and umbrella sticks.................... | 40,000 | ...... | 49 50 | ......... | 40,000 |
| Total................. | 8,754,800 | *91.9 | ...... | 2,397,850 | 6,152,800 |

* All others (less than 100 M.) = 8.1 per cent.

TABLE 74 — SPANISH CEDAR

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 100 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Cigar boxes................ | 8,580,500 | 98.9 | $113 08 | ......... | 8,580,500 |
| Musical instruments......... | 2,500 | ...... | 250 00 | ......... | 2,500 |
| Total................. | 8,583,500 | *98.9 | ...... | ......... | 8,583,500 |

* All others (less than 100 M.) = 1.1 per cent.

TABLE 75 — PITCH PINE

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Boxes and crates, packing.... | 2,765,000 | 45.9 | $18 87 | 245,000 | 2,520,000 |
| Planing mill products........ | 1,757,600 | 29.1 | 18 67 | 1,754,600 | 3,000 |
| Elevators.................. | 1,234,000 | 20.4 | ...... | ......... | .......... |
| Sash, doors, blinds and general mill work................ | 72,000 | ...... | 23 82 | 72,000 | .......... |
| Dairymen's, poulterers' and apiarists' supplies......... | 35,000 | ...... | 12 74 | ......... | 35,000 |
| Vehicles and vehicle parts.... | 15,000 | ...... | 20 00 | 15,000 | .......... |
| Baskets and fruit packages... | 10,000 | ...... | 24 00 | 10,000 | .......... |
| Refrigerators and kitchen cabinets.................... | 25,000 | ...... | 18 00 | 25,000 | .......... |
| Tanks and silos............. | 50,000 | ...... | 25 00 | 50,000 | .......... |
| Patterns and flasks.......... | 60,000 | ...... | 24 33 | 60,000 | .......... |
| Total.................. | 6,023,600 | *95.4 | ...... | 2,231,600 | 2,558,000 |

* All others (less than 500 M.) = 4.6 per cent.

TABLE 76 — WESTERN WHITE PINE

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Sash, doors, blinds and general mill work................ | 2,462,000 | 62.5 | $41 37 | ......... | 2,462,000 |
| Planing mill products........ | 1,050,000 | 26.6 | 37 38 | ......... | 1,050,000 |
| Dairymen's, poulterers' and apiarists' supplies......... | 100,000 | ...... | 20 00 | ......... | 100,000 |
| Ship and boat building....... | 300,000 | ...... | 53 33 | ......... | 300,000 |
| Vehicles and vehicle parts.... | 23,000 | ...... | 37 00 | ......... | 23,000 |
| Total.................. | 3,935,000 | *89.1 | ...... | ......... | 3,935,000 |

* All others (less than 500 M.) = 10.9 per cent.

TABLE 77 — CHERRY (BLACK)

| Name of Industry | Quantity used annually | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Fixtures | 1,150,000 | 35.4 | $47 43 | 55,000 | 1,095,000 |
| Printing material | 577,000 | 17.7 | 48 28 | 27,000 | 550,000 |
| Professional and scientific instruments | 315,700 | 9.4 | 53 71 | 60,000 | 255,700 |
| Clocks | 300,000 | 9.2 | 30 00 | .......... | 300,000 |
| Furniture | 245,550 | 7.5 | 38 49 | 171,150 | 74,400 |
| Planing mill products | 124,000 | 3.8 | 35 80 | 59,000 | 65,000 |
| Musical instruments | 120,000 | 3.7 | 45 13 | 109,000 | 11,000 |
| Sash, doors, blinds and general mill work | 116,900 | 3.5 | 67 04 | 63,600 | 53,300 |
| Car construction | 37,500 | ...... | 84 45 | .......... | 37,500 |
| Ship and boat building | 89,200 | ...... | 68 09 | 53,900 | 35,300 |
| Boot and shoe findings | 25,000 | ...... | 30 00 | 25,000 | .......... |
| Chairs | 16,000 | ...... | 35 25 | 16,000 | .......... |
| Caskets and coffins | 11,000 | ...... | 56 82 | 1,000 | 10,000 |
| Baskets and fruit packages | 44,000 | ...... | 18 41 | 44,000 | .......... |
| Woodenware and novelties | 12,000 | ...... | 20 00 | 12,000 | .......... |
| Laundry appliances | 2,000 | ...... | 72 50 | .......... | 2,000 |
| Electrical machinery and apparatus | 12,000 | ...... | 50 00 | 12,000 | .......... |
| Machine construction | 4,500 | ...... | 29 33 | 4,000 | 500 |
| Patterns and flasks | 2,500 | ...... | 87 60 | 500 | 2,000 |
| Brushes and brooms | 2,000 | ...... | 30 00 | 2,000 | .......... |
| Shuttles, spools and bobbins | 5,000 | ...... | 25 00 | 5,000 | .......... |
| Dowels | 10,000 | ...... | 35 00 | 10,000 | .......... |
| Playground equipment | 15,000 | ...... | 18 00 | 15,000 | .......... |
| Vehicles and vehicle parts | 5,900 | ...... | 42 54 | 2,900 | 3,000 |
| Total | 3,242,750 | *90.2 | ...... | 748,050 | 2,494,700 |

* All others (less than 100 M.) = 9.8 per cent.

Table 78 — Black Walnut

| Name of Industry | Quantity used annually | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Musical instruments | 698,600 | 26.5 | $111 76 | 26,100 | 672,500 |
| Furniture | 558,501 | 21.2 | 172 81 | 3,575 | 554,926 |
| Sash, doors, blinds and general mill work | 422,000 | 16.0 | 114 21 | 257,000 | 165,000 |
| Firearms | 370,000 | 14.1 | 68 65 | .......... | 370,000 |
| Planing mill products | 291,000 | 11.0 | 113 87 | 260,100 | 31,500 |
| Vehicles and vehicle parts | 23,100 | 8.7 | 87 45 | 100 | 23,000 |
| Chairs | 5,200 | ...... | 42 12 | 5,000 | 200 |
| Fixtures | 71,500 | ...... | 90 91 | .......... | 71,500 |
| Caskets and coffins | 13,000 | ...... | 89 62 | 8,000 | 5,000 |
| Woodenware and novelties | 200 | ...... | 40 00 | 200 | .......... |
| Picture frames and mouldings | 46,600 | ...... | 113 13 | .......... | 46,600 |
| Electrical machinery and apparatus | 59,700 | ...... | 114 19 | .......... | 59,700 |
| Sporting and athletic goods | 10,000 | ...... | 90 00 | .......... | 10,000 |
| Clocks | 28,527 | ...... | 70 00 | .......... | 28,527 |
| Whips, canes and umbrella sticks | 20,000 | ...... | 51 00 | .......... | 20,000 |
| Brushes and brooms | 600 | ...... | 30 00 | 600 | .......... |
| Miscellaneous | 10,000 | ...... | 69 00 | 10,000 | .......... |
| Total | 2,628,528 | *97.5 | ...... | 570,675 | 2,058,453 |

* All others (less than 100 M.) = 2.5 per cent.

Table 79 — Tamarack

| Name of Industry | Quantity used annually | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Sash, doors, blinds and general mill work | 1,015,000 | 48.3 | $17 97 | 15,000 | 1,000,000 |
| Planing mill products | 1,000,000 | 48.1 | 18 00 | .......... | 1,000,000 |
| Boxes and crates, packing | 50,000 | ...... | 20 00 | .......... | 50,000 |
| Pumps | 12,000 | ...... | 20 00 | 12,000 | .......... |
| Total | 2,077,000 | *96.4 | ...... | 27,000 | 1,050,000 |

* All others (less than 500 M.) = 3.6 per cent.

TABLE 80 — SUGAR PINE

| Name of Industry | Quantity used annually | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Sash, doors, blinds and general mill work | 1,397,100 | 84.8 | $43 15 | ......... | 1,397,100 |
| Musical instruments | 150,000 | 9.1 | 79 00 | ......... | 150,000 |
| Planing mill products | 100,000 | ...... | 50 00 | ......... | 100,000 |
| Total | 1,647,100 | *93.9 | ...... | ......... | 1,647,100 |

* All others (less than 100 M.) = 6.1 per cent.

TABLE 81 — ARBOR VITAE

| Name of Industry | Quantity used annually | | Average cost per 1,000 feet | Grown in New York. | Grown out of New York. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Electrical machinery and apparatus | 735,000 | 45.2 | $11 01 | 735,000 | .......... |
| Dairymen's, poulterers' and apiarists' supplies | 250,000 | 16.0 | 34 00 | .......... | 250,000 |
| Planing mill products | 217,000 | 15.8 | 22 47 | 115,000 | 102,000 |
| Tanks and silos | 240,000 | 14.7 | 37 50 | .......... | 240,000 |
| Ship and boat building | 177,600 | 10.9 | 52 08 | 79,700 | 97,900 |
| Sash, blinds, doors and general mill work | 4,000 | ...... | 60 00 | ......... | 4,000 |
| Total | 1,623,600 | *99.6 | ...... | 929,700 | 693,900 |

* All others = 0.4 per cent.

TABLE 82 — DOUGLAS FIR

| Name of Industry | Quantity used annually: Feet b. m. | Quantity used annually: Per cent | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| Sash, doors, blinds and general mill work | 571,100 | 37.7 | $44 82 | ......... | 571,100 |
| Ship and boat building | 565,000 | 37.5 | 56 17 | ......... | 565,000 |
| Car construction | 180,000 | 11.8 | 48 00 | ......... | 180,000 |
| Vehicles and vehicle parts | 87,500 | 5.7 | 90 00 | ......... | 87,500 |
| Woodenware and novelties | 65,000 | 4.0 | 43 05 | ......... | 65,000 |
| Planing mill products | 29,000 | 1.8 | 43 10 | ......... | 29,000 |
| Musical instruments | 10,000 | ...... | 65 00 | ......... | 10,000 |
| Playground equipment | 1,000 | ...... | 70 00 | ......... | 1,000 |
| Total | 1,508,600 | *98.5 | ...... | ......... | 1,508,600 |

* All others (less than 20 M.) = 1.5 per cent.

TABLE 83 — COTTON GUM

| Name of Industry | Quantity used annually: Feet b. m. | Quantity used annually: Per cent | Average cost per 100 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| Cigar boxes | 891,800 | 64.2 | $48 14 | ......... | 891,800 |
| Clocks | 322,816 | 23.2 | 34 15 | ......... | 322,816 |
| Sash, doors, blinds and general mill work | 117,500 | 8.6 | 32 30 | ......... | 117,500 |
| Boxes and crates, packing | 41,500 | ...... | 19 50 | ......... | 41,500 |
| Vehicles and vehicle parts | 15,000 | ...... | 22 00 | ......... | 15,000 |
| Total | 1,388,616 | *96.0 | ...... | ......... | 1,388,616 |

* All others (less than 100 M.) = 4.0 per cent.

Over 21,000,000 board feet of sugar maple or its equivalent are annually made into last blocks. New York has a number of factories turning out these blocks, especially in the northern counties of the State. The raw material is purchased in the bolt form, for which about $12.50 per thousand board feet is paid at the factory.

Photograph by NELSON C. BROWN.

TABLE 84 — WESTERN RED CEDAR

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Planing mill products | 999,200 | 80.3 | $26 39 | ......... | 999,200 |
| Ship and boat building | 119,000 | ...... | 49 75 | ......... | 119,000 |
| Sash, doors, blinds and general mill work | 127,000 | 10.2 | 48 23 | ......... | 127,000 |
| Total | 1,245,200 | 100 | ...... | ......... | 1,245,200 |

TABLE 85 — BALSAM FIR

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Sash, doors, blinds and general mill work | 576,800 | 65.1 | $33 68 | 51,800 | 525,000 |
| Planing mill products | 193,000 | 21.8 | 21 24 | 193,000 | .......... |
| Boxes and crates, packing | 100,000 | 11.3 | 18 00 | 100,000 | .......... |
| Dairymen's, poulterers' and apiarists' supplies | 14,000 | ...... | 19 71 | 14,000 | .......... |
| Total | 883,800 | *98.2 | ...... | 358,800 | 525,000 |

* All others (less than 25 M.) = 1.8 per cent.

TABLE 86 — WESTERN YELLOW PINE

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 100 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Sash, doors, blinds and general mill work | 675,000 | 77.1 | $40 22 | ......... | 675,000 |
| Ship and boat building | 200,000 | 22.9 | 27 50 | ......... | 200,000 |
| Total | 875,000 | 100.00 | ...... | ......... | 875,000 |

TABLE 87 — REDWOOD

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Planing mill products........ | 302,000 | 39.3 | $41 13 | ......... | 302,000 |
| Sash, blinds, doors and general mill work................ | 205,000 | 26.7 | 38 80 | ......... | 205,000 |
| Refrigerators and kitchen cabinets..................... | 155,000 | 20.2 | 34 84 | ......... | 155,000 |
| Musical instruments.......... | 65,000 | 8.4 | 56 15 | ......... | 65,000 |
| Caskets and coffins........... | 15,000 | ...... | 55 00 | ......... | 15,000 |
| Signs and supplies............ | 3,000 | ...... | 80 00 | ......... | 3,000 |
| Patterns and flasks........... | 2,700 | ...... | 65 00 | ......... | 2,700 |
| Signs and patterns........... | 3,000 | ...... | 80 00 | ......... | 3,000 |
| Total.................. | 750,700 | *94.6 | ...... | ......... | 750,700 |

* All others (less than 50 M.) = 5.4 per cent.

TABLE 88 — BUTTERNUT

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Furniture.................. | 500,000 | 65.29 | $40 00 | ......... | 500,000 |
| Fixtures.................... | 50,000 | 6.529 | 45 00 | ......... | 50,000 |
| Excelsior.................... | 50,000 | 6.529 | 16 00 | 50,000 | .......... |
| Musical instruments.......... | 45,000 | 5.87 | 35 29 | 12,000 | 33,000 |
| Woodenware and novelties... | 39,000 | 5.09 | 20 00 | 39,000 | .......... |
| Professional and scientific instruments................ | 30,000 | 3.91 | 45 00 | 30,000 | .......... |
| Planing mill products......... | 5,200 | ...... | 20 19 | 5,200 | .......... |
| Sash, doors, blinds and general mill work................ | 10,500 | ...... | 61 15 | 4,700 | 5,800 |
| Dairymen's, poulterers' and apiarists' supplies......... | 5,000 | ...... | 18 00 | 5,000 | .......... |
| Ship and boat building....... | 11,000 | ...... | 67 73 | 1,000 | 10,000 |
| Vehicles and vehicle parts.... | 1,000 | ...... | 18 00 | 1,000 | .......... |
| Agricultural inplements...... | 8,000 | ...... | 30 00 | 8,000 | .......... |
| Baskets and fruit packages... | 1,000 | ...... | 25 00 | 1,000 | .......... |
| Toys..................... | 10,000 | ...... | 18 00 | 10,000 | .......... |
| Total................. | 765,700 | *93.22 | ...... | 166,900 | 598,800 |

All others (less than 25,000 feet) = 6.78 per cent.

TABLE 89 — LIGNUM VITAE

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 100 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Furniture | 375,000 | 56.5 | $68 00 | ......... | 375,000 |
| Sporting and athletic goods | 225,000 | 33.9 | 200 00 | ......... | 225,000 |
| Ship and boat building | 2,000 | ...... | 275 00 | ......... | 2,000 |
| Handles | 1,500 | ...... | 250 00 | ......... | 1,500 |
| Pulleys and conveyors | 60,000 | ...... | 250 00 | ......... | 60,000 |
| Total | 663,500 | *90.4 | ...... | ......... | 663,500 |

* All others (less than 100 M.) = 9.6 per cent.

TABLE 90 — CIRCASSIAN WALNUT

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost f. o. b. factory | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m | Per cent | | | |
| Musical instruments | 221,750 | 35.6 | $251 41 | ......... | 221,750 |
| Sash, blinds, doors and general mill work | 144,550 | 23.2 | 303 63 | ......... | 144,550 |
| Furniture | 119,950 | 19.2 | 304 41 | ......... | 119,950 |
| Fixtures | 53,500 | 8.5 | 207 66 | ......... | 53,500 |
| Planing mill products | 8,200 | ...... | 320 00 | ......... | 8,200 |
| Ship and boat building | 25,000 | ...... | 200 00 | ......... | 250,000 |
| Caskets and coffins | 5,000 | ...... | 250 00 | ......... | 5,000 |
| Refrigerators and kitchen cabinets | 500 | ...... | 150 00 | ......... | 500 |
| Cigar boxes | 250 | ...... | 300 00 | ......... | 250 |
| Picture frames and mouldings | 5,000 | ...... | 320 00 | ......... | 5,000 |
| Electrical machinery | 13,400 | ...... | 250 00 | ......... | 13,400 |
| Sporting and athletic goods | 25,000 | ...... | 200 00 | ......... | 25,000 |
| Total | 622,100 | *86.5 | ...... | ......... | 847,100 |

* All others (less than 50 M.) = 13.5 per cent.

TABLE 91 — WESTERN LARCH

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. | Grown out of New York. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Tanks and silos | 420,000 | 100.00 | $29 40 | ......... | 420,000 |
| **ASPEN** | | | | | |
| Boxes and crates, packing | 316,000 | 87.2 | $18 61 | 10,000 | 306,000 |
| Dairymen's, poulterers' and apiarists' supplies | 40,000 | 11.0 | ...... | ......... | ......... |
| Sash, doors, blinds and general mill work | 1,200 | ...... | 22 00 | 1,200 | ......... |
| Woodenware and novelties | 5,000 | ...... | ...... | ......... | ......... |
| Total | 362,200 | *98.2 | ...... | 11,200 | 306,000 |
| **EBONY** | | | | | |
| Sporting and athletic goods | 189,000 | 70.2 | $75 00 | ......... | 189,000 |
| Sash, doors, blinds and general mill work | 50,000 | 19.6 | 262 50 | ......... | 50,000 |
| Whips, canes and umbrella sticks | 10,000 | 3.9 | 250 00 | ......... | 10,000 |
| Brushes and brooms | 5,000 | 1.9 | 250 00 | ......... | 5,000 |
| Handles | 654 | ...... | 330 00 | ......... | 654 |
| Total | 254,654 | †95.6 | ...... | ......... | 254,654 |

* All others (less than 10,000 feet) = 1.8 per cent.
† All others (less than 1 M.) = 4.4 per cent.

TABLE 92 — CUCUMBER

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Dairymen's, poulterers' and apiarists' supplies | 100,000 | 34.1 | $15 00 | 100,000 | ......... |
| Planing mill products | 89,500 | 30.5 | 36 14 | ......... | 89,500 |
| Woodenware and novelties | 37,000 | 12.6 | 20 00 | 37,000 | ......... |
| Caskets and coffins | 20,000 | 6.8 | 33 50 | ......... | 20,000 |
| Picture frames and mouldings | 20,000 | 6.8 | ...... | ......... | ......... |
| Sash, doors, blinds and general mill work | 10,000 | ...... | 50 00 | ......... | 10,000 |
| Furniture | 16,000 | ...... | 53 75 | 16,000 | ......... |
| Total | 292,500 | *90.8 | ...... | 153,000 | 119,500 |

* All others (less than 20 M.) = 9.2 per cent.

TABLE 93 — BLACK GUM

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Boxes and crates, packing.... | 210,000 | 100 | $18 29 | ......... | 210,000 |

TABLE 94 — TEAK

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Sash, doors, blinds and general mill work................ | 100,000 | 52.41 | $287 50 | ......... | 100,000 |
| Ship and boat building....... | 74,000 | 38.77 | 241 48 | ......... | 74,000 |
| Planing mill products........ | 6,800 | ...... | 213 24 | ......... | 6,800 |
| Sporting and athletic goods... | 10,000 | ...... | 200 00 | ......... | 10,000 |
| Total.................. | 190,800 | *91.18 | ...... | ......... | 190,800 |

* All others (less than 50 M.) = 8.82 per cent.

TABLE 95 — SYCAMORE

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Planing mill products......... | 102,700 | 56.2 | $39 69 | 2,700 | 100,000 |
| Boxes and crates, packing.... | 50,000 | 27.4 | 28 00 | ......... | 50,000 |
| Furniture.................. | 28,012 | 15.3 | 43 77 | ......... | 28,012 |
| Vehicles and vehicle parts.... | 2,000 | ...... | 35 00 | ......... | 2,000 |
| Total.................. | 182,712 | *98.9 | ...... | 2,700 | 180,012 |

* All others (less than 5 M.) = 1.1 per cent.

TABLE 96 — LOCUST

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Ship and boat building...... | 27,028 | 86.1 | $51 37 | ......... | .......... |
| Sash, doors, blinds and general mill work................ | 20,000 | 13.5 | 100 00 | 63,400 | 63,628 |
| Patterns and flasks.......... | 500 | ...... | 40 00 | 500 | 20,000 |
| Total.................. | 147,528 | *99.6 | ...... | 63,900 | 83,628 |

* All others (less than 1,000 feet) = 0.4 per cent.

TABLE 97 — PERSIMMON

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Boat and ship building...... | 94,000 | 100 | $98 60 | ......... | 94,000 |
| | **ROSEWOOD** | | | | |
| Fixtures.................... | 29,340 | 46.0 | 256 61 | ......... | 29,340 |
| Sporting and athletic goods... | 24,400 | 36.7 | 170 00 | ......... | 24,400 |
| Sash, doors, blinds and general mill work................ | 3,000 | 4.7 | 233 33 | ......... | 3,000 |
| Electrical machinery and apparatus................... | 2,260 | 3.3 | 250 00 | ......... | 2,260 |
| Furniture................... | 2,000 | 3.1 | 220 00 | ......... | 2,000 |
| Musical instruments......... | 950 | ...... | 298 00 | ......... | 950 |
| Cigar boxes................. | 100 | ...... | 250 00 | ......... | 100 |
| Picture frames and mouldings | 750 | ...... | 240 00 | ......... | 750 |
| Handles..................... | 610 | ...... | 140 00 | ......... | 610 |
| Brushes and brooms......... | 300 | ...... | 200 00 | ......... | 300 |
| Total.................. | 63,710 | *93.8 | ...... | ......... | 63,710 |

* All others (less than 1,000 feet) = 6.2 per cent.

TABLE 98 — BUCKEYE

| Name of Industry | Quantity Used Annually: Feet b. m. | Quantity Used Annually: Per cent | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| Boxes and crates, packing | 50,000 | 81.4 | $26 00 | ......... | 50,000 |
| Musical instruments | 6,000 | 9.7 | 25 00 | ......... | 6,000 |
| Sash, doors, blinds and general mill work | 5,400 | 8.9 | 26 85 | 2,000 | 3,400 |
| Total | 61,400 | 100.00 | ...... | ......... | 59,400 |
| **WITCH HAZEL** | | | | | |
| Sash, doors, blinds and general mill work | 56,500 | 100.00 | $35 88 | ......... | 56,500 |
| **SATINWOOD** | | | | | |
| Sash, doors, blinds and general mill work | 33,000 | 64.1 | $258 18 | ......... | 33,000 |
| Furniture | 8,450 | 16.4 | 247 10 | ......... | 8,450 |
| Musical instruments | 5,000 | 9.7 | 250 00 | ......... | 5,000 |
| Caskets and coffins | 5,000 | 9.7 | 250 00 | ......... | 5,000 |
| Total | 51,450 | 100.00 | ...... | ........ | 51,450 |

TABLE 99 — ENGLISH OAK

| Name of Industry | Quantity Used Annually: Feet b. m. | Quantity Used Annually: Per cent | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| Furniture | 20,000 | 54.9 | $350 00 | ......... | 20,000 |
| Planing mill products | 10,000 | 27.4 | 350 00 | ......... | 10,000 |
| Sash, doors, blinds and general mill work | 6,380 | 17.5 | 302 19 | ......... | 6,380 |
| Total | 36,380 | 100.00 | ...... | ......... | 36,380 |

TABLE 100 — SITKA SPRUCE

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Sash, doors, blinds and general mill work | 25,000 | 92.5 | $45 00 | ......... | 25,000 |
| Musical instruments | 2,000 | 7.5 | 100 00 | ......... | 2,000 |
| Total | 27,000 | 100.00 | ...... | ......... | 27,000 |

TABLE 101 — BOXWOOD

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Professional and scientific instruments | 25,000 | 100.00 | $100 00 | ......... | 25,000 |

TABLE 102 — APPLEWOOD

| NAME OF INDUSTRY | QUANTITY USED ANNUALLY | | Average cost per 1,000 feet | Grown in New York. Feet b. m. | Grown out of New York. Feet b. m. |
|---|---|---|---|---|---|
| | Feet b. m. | Per cent | | | |
| Handles | 22,000 | 95.6 | $68 50 | ......... | 22,000 |
| Vehicles and vehicle parts | 1,000 | 4. | 20 00 | 1,000 | .......... |
| Total | 23,000 | 100.00 | ...... | 1,000 | 22,000 |

# PART IV

## Directory of Wood-using Industries

## DIRECTORY OF WOOD-USING INDUSTRIES

The following is a list of the manufacturers who co-operated in the collection of the data contained in this report. Occasionally a firm failed to give the desired data and estimates from the next best available source were taken. A great many wood-using establishments including cooperage, poles, tires, veneer and assembling establishments are not covered by this investigation, but reported by the United States Census and summarized in this report. Manufacturers who produce several products will appear in this list under more than one industry. Many manufacturers make boxes and crates for their own use only.

### ALBANY COUNTY.

AGRICULTURAL IMPLEMENTS.

P. K. Dederick's Sons .......... Albany.

BASKET AND FRUIT PACKAGES.

Albany Basket Co .......... Albany.

BOATS AND SHIPS.

Department of Public Works, State of New York ... Albany.
J. H. Hunt .......... Watervliet.

BOOT AND SHOE FINDINGS.

Albany Last Co .......... Albany.

BOXES, CIGAR.

H. A. Wolfram .......... Watervliet.

BOXES AND CRATES, PACKING.

Annesley & Co .......... Albany.
Henry W. Draper .......... Albany.
T. F. Romeyn Co .......... Albany.
M. Breault & Co .......... Cohoes.
Hudson River Box Co .......... Cohoes.
H. A. Wolfram .......... Watervliet.

CAR CONSTRUCTION.

Delaware and Hudson Railroad car shops .......... Watervliet.
J. H. Jones' Sons Co .......... Watervliet.

CASKETS, ETC.

Albany Casket Co .......... Albany.

### ALBANY COUNTY — (Continued).

#### FIXTURES.

Laib Bros.................................... Albany.
George Spalt ................................ Albany.
James T. Young............................... Watervliet.

#### FURNITURE.

Annesley & Co................................ Albany.
W. Hoffer Furniture Co....................... Cohoes.
James T. Young............................... Watervliet.

#### HANDLES.

Stephen Kampf ............................... Albany.

#### INSTRUMENTS, MUSICAL.

Boardman & Gray.............................. Albany.

#### MACHINERY AND APPARATUS, ELECTRICAL.

LaRose Mfg. Co............................... Albany.

#### PLANING MILL PRODUCTS.

Blakeslee Lumber Co.......................... Albany.
Cameron & Hawn............................... Albany.
Hart & Fleet................................. Albany.
Laib Bros.................................... Albany.
Ramsdill & Co................................ Albany.
William Taafe's Sons......................... Albany.
Cohoes Union Bobbin Works.................... Cohoes.
G. H. Crandall & Co.......................... Cohoes.
Stephen Brazee .............................. Preston Hollow.
P. T. Aussen................................. South Bethlehem.
Clayton Swartout ............................ South Westerlo.
J. H. Wood................................... Whitesville.

#### PLUMBER'S WOODWORK.

LaRose Mfg. Co. ............................. Albany.

#### PULLEYS AND CONVEYORS.

M. W. Reynolds............................... Whitesville.

#### SASH, DOORS, BLINDS, AND GENERAL MILL WORK.

Blakeslee Lumber Co.......................... Albany.
William H. Burton Co......................... Albany.
Laib Bros ................................... Albany.
Thomas Stephens & Sons....................... Albany.
A. J. Griffin & Son.......................... Cohoes.
Universal Wood Working Co.................... Cohoes.
Stephen Brazee .............................. Preston Hollow.
James T. Young............................... Watervliet.

#### SHUTTLES, BOBBINS, SPOOLS.

Cohoes Union Bobbin Co....................... Cohoes.

## ALBANY COUNTY — (Continued).

### SIGNS AND SUPPLIES.

Laib Bros .................................... Albany.

### TOYS.

The Embossing Co.............................. Albany.

### VEHICLES.

James Goold Co................................ Albany.
Kingsbury-Leahy Co ........................... Albany.
Knox & Shaible................................ Albany.
A. Mosher & Sons.............................. Albany.
Seim & Reissig................................ Albany.
H. C. Becker.................................. Albany.
Charles Richenecker .......................... Albany.

### WOODENWARE AND NOVELTIES.

John S. Tilley................................ Watervliet.

### MISCELLANEOUS.

#### Bungs and Faucets.

Stephen Kampf ................................ Albany.

## ALLEGANY COUNTY.

### BASKETS AND FRUIT PACKAGES.

American Novelty Co........................... Wellsville.

### BOAT AND SHIP BUILDING.

H. Becker .................................... Centerville.

### BOOT AND SHOE FINDINGS.

Seger-Prindle Mfg. Co......................... Belvidere.

### CAR CONSTRUCTION.

Pittsburg, Shawmut and Northern Railroad car shops Angelica.

### CASKETS AND COFFINS.

F. L. Knowles Casket Co....................... Wellsville.

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

F. W. Howard.................................. Alfred.
George Calhoon & Co........................... Andover.
Cuba Cheese Box Co............................ Cuba.
S. C. Swift Mfg. Co........................... Cuba.
Wasson-Stanchion Co........................... Cuba.
Mason-Young Co................................ Fillmore.
A. M. Tarbell................................. Rushford.

### FURNITURE.

Coats Mfg. Co................................. Wellsville.
Wellsville Upholstering Co.................... Wellsville.

Hardwood lumber, chiefly hard maple, yellow birch, beech, elm and basswood seasoning in the yard preparatory to being sent to the many wood-using industries of the State for further manufacture into flooring, furniture, implements, machinery, boat building, instruments and a great many other wood products. We should grow all of the wood used in the State, instead of sending over $60,000,000 to other States for this material every year. Photograph by NELSON C. BROWN.

**ALLEGANY COUNTY** — (Continued).

HANDLES.

| | |
|---|---|
| W. F. & F. J. Fos | Oramel. |
| American Novelty Co | Wellsville. |

LAUNDRY APPLIANCES.

| | |
|---|---|
| The Seger & Prindle Mfg. Co | Belvidere. |

PLANING MILL PRODUCTS.

| | |
|---|---|
| Almer E. Travis | Angelica. |
| A. B. Weir | Belfast. |
| Parker & Root | Bolivar. |
| Charles L. Wheeler | Canaseraga. |
| J. W. Hutchins | Cuba. |
| Phelps & Sibley Co | Cuba. |
| C. Thomson & Son | Friendship. |
| Edward Common | Fillmore. |
| A. M. Tarbell | Rushford. |
| F. L. Knowles Casket Co | Wellsville. |
| Duke Oak Lumber Co | Wellsville. |
| G. S. Van Buskirk | Wiscoy. |

PULLEYS AND CONVEYORS.

| | |
|---|---|
| George L. Estes | Cuba. |

REFRIGERATORS AND KITCHEN CABINETS.

| | |
|---|---|
| F. L. Knowles Casket Co | Wellsville. |
| Phelps & Sibley Co | Cuba. |
| Duke Oak Lumber Co | Wellsville. |
| G. S. Van Buskirk | Wiscoy. |

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

| | |
|---|---|
| Belmont Lumber Co | Belmont. |
| Parker & Root | Bolivar. |
| Empire Sash and Door Co | Friendship. |

ROLLERS, SHADE AND MAP.

| | |
|---|---|
| Phelps & Sibley Co | Cuba. |
| Duke Oak Lumber Co | Wellsville. |
| F. L. Knowles Casket Co | Wellsville. |
| G. S. Van Buskirk | Wiscoy. |

TANKS AND SILOS.

| | |
|---|---|
| H. B. Renyard | Whitney's Crossing. |

WOODENWARE AND NOVELTIES.

| | |
|---|---|
| Stanley C. Swift Mfg. Co | Cuba. |
| American Novelty Co | Wellsville. |

## BROOME COUNTY.

### BASKETS AND FRUIT PACKAGES.

J. C. Fish .......... Corbettsville.

### BOXES, CIGAR.

Binghamton Cigar Box Co .......... Binghamton.
Lacey's Cigar Box Co .......... Binghamton.
F. B. & G. W. Lacey .......... Binghamton.

### BOXES AND CRATES, PACKING.

Binghamton Lounge Co .......... Binghamton.
Osgood Scale Co .......... Binghamton.
Sturtevant-Larrabee Co .......... Binghamton.
Wilkinson Mfg. Co .......... Binghamton.
Lestershire Lumber and Box Co .......... Lestershire.
Hobbs Bros .......... Nineveh.
W. S. Allen Mfg. Co .......... Whitney Point.
Otselic Mfg. Co .......... Whitney Point.

### CHAIRS.

Binghamton Chair Co .......... Binghamton.
Steele & Ahl Co .......... Binghamton.

### DAIRYMEN, POULTERERS' AND APIARISTS' SUPPLIES.

C. T. Dickinson .......... Whitney Point.
Otselic Mfg. Co .......... Whitney Point.

### FURNITURE.

Binghamton Lounge Co .......... Binghamton.
Stickley Brandt Chair Co .......... Binghamton.
Wilkinson Mfg. Co .......... Binghamton.
Lestershire Furniture Co .......... Lestershire.
W. S. Allen Mfg. Co .......... Whitney Point.

### HANDLES.

John J. Potter .......... Binghamton.
C. F. McIntyre .......... Maine.

### INSTRUMENTS, PROFESSIONAL.

Ansco Co. Camera Works .......... Lestershire.

### LAUNDRY APPLIANCES.

Lestershire Lumber and Box Co .......... Lestershire.

### PLANING MILL PRODUCTS.

Bartlett & Co .......... Binghamton.
F. B. & J. W. Lacey .......... Binghamton.
L. D. & William Van Antwerp .......... Binghamton.
Deposit Lumber Co .......... Deposit, N. Y.
Lestershire Lumber and Box Co .......... Lestershire.
Harry Stevens .......... Union.
B. Howard .......... Union Center.

## BROOME COUNTY — (Continued).

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Bartlett & Co. . . . . . . . . . Binghamton.
Junius F. Bishop. . . . . . . . . . Binghamton.
James O'Neil . . . . . . . . . . Binghamton.
A. Robertson & Son. . . . . . . . . . Binghamton.
Claremont E. Smith & Co. . . . . . . . . . Binghamton.
Light-Unkefer Co. . . . . . . . . . Endicott.
E. D. & P. Hilsinger. . . . . . . . . . Killawog.
Lestershire Lumber and Box Co. . . . . . . . . . Lestershire.

### SHUTTLES, SPOOLS, BOBBINS.

Lestershire Spool and Mfg. Co. . . . . . . . . . Lestershire.

### TANKS AND SILOS.

E. B. Lacey. . . . . . . . . . Union.

### TOYS.

Wilkinson Mfg. Co. . . . . . . . . . Binghamton.

### VEHICLES, ETC.

A. L. Davis' Sons. . . . . . . . . . Binghamton.
McMahon Wagon Co. . . . . . . . . . Binghamton.
Sturtevant-Larrabee Co. . . . . . . . . . Binghamton.
E. D. & P. Hilsinger. . . . . . . . . . Killawog.
George E. Norton. . . . . . . . . . Maine.
Hobbs Bros. . . . . . . . . . Nineveh.
Jay B. Baker. . . . . . . . . . Sanitaria Springs.

### WOODENWARE AND NOVELTIES.

John J. Potter. . . . . . . . . . Binghamton.
E. D. & P. Hilsinger. . . . . . . . . . Killawog.
W. L. Lewis. . . . . . . . . . Lisle.

### MISCELLANEOUS.

#### Scales.

Jones of Binghamton, Inc. . . . . . . . . . Binghamton.
Osgood Scale Co. . . . . . . . . . Binghamton.

## CATTARAUGUS COUNTY.

### BOOT AND SHOE FINDINGS.

Ellicottville Milling Co. . . . . . . . . . Ellicottville.
Fitzpatrick & Weller. . . . . . . . . . Ellicottville.
Thomas F. McMahon. . . . . . . . . . Ellicottville.
B. C. Beach. . . . . . . . . . Elton.
E. R. Washburn. . . . . . . . . . Franklinville.
J. E. Chase & Son. . . . . . . . . . Great Valley.
N. L. Walrath. . . . . . . . . . Great Valley.
William J. Van Dewater Est. . . . . . . . . . Machias.
Land Roller Mfg. Co. . . . . . . . . . Sandusky.
F. A. Capron. . . . . . . . . . West Valley.
T. F. Kruse. . . . . . . . . . West Valley.
The O'Dell & Eddy Co. . . . . . . . . . Yorkshire.

## CATTARAUGUS COUNTY — (Continued).

### BOXES AND CRATES, PACKING.

| | |
|---|---|
| Oakes & Burger | Cattaraugus. |
| Borden's Condensed Milk | Ellicottville. |
| Franklinville Canning Co | Franklinville. |
| Acme Glass Co | Olean. |
| Olean Glass Co | Olean. |

### CAR CONSTRUCTION.

| | |
|---|---|
| Pennsylvania Railroad Co | Olean. |

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

| | |
|---|---|
| Oakes & Burger | Cattaraugus. |
| Setter Bros. Co | Cattaraugus. |
| O. Hawkins | East Otto. |
| Fred Woodmancy | East Randolph. |
| Block Bros. & Co | Great Valley. |
| Joseph Kopydloske | Otto. |
| T. F. Kruse | West Valley. |

### FURNITURE.

| | |
|---|---|
| J. F. Dominick | Salamanca. |
| Fancher Furniture Co | Salamanca. |
| Salamanca Furniture Works | Salamanca. |
| Sterling Furniture Co | Salamanca. |

### PROFESSIONAL INSTRUMENTS.

| | |
|---|---|
| B. C. Beach | Elton. |

### MACHINE CONSTRUCTION.

| | |
|---|---|
| E. F. Smith | Allegany. |

### PATTERNS AND FLASKS.

| | |
|---|---|
| Gowanda Agricultural Works | Gowanda. |
| The Star Iron Works | Gowanda. |

### PLANING MILL PRODUCTS.

| | |
|---|---|
| Goo & Hopkins | Delevan. |
| L. V. Sikes | East Otto. |
| A. A. Stewart | East Randolph. |
| Rust & Olin | Ellicottville. |
| B. C. Beach | Elton. |
| Dean Lumber Co | Gowanda. |
| A. Weston Lumber Co | Olean. |
| Robert G. Potter | Onoville. |
| A. J. Sample | Randolph. |
| G. F. Miller & Son | Salamanca. |
| Salamanca Lumber Co | Salamanca. |
| Harding Morse | Steamburg. |

### PRINTING MATERIAL.

| | |
|---|---|
| Setter Bros. Co | Cattaraugus. |
| The Gowanda Pump Works | Gowanda. |

## CATTARAUGUS COUNTY — (Continued).

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

| | |
|---|---|
| William H. Hall | Allegany. |
| E. W. Clapp | Conewango Valley. |
| Goo & Hopkins | Delevan. |
| J. L. Richardson | Elton. |
| Forbush Planing Mill Co | Gowanda. |
| William J. Van Dewater Est | Machias. |
| Olean Glass Co | Olean. |
| Olean Planing Mill Co., Inc | Olean. |
| A. Weston Lumber Co | Olean. |
| W. R. Wright Mfg. Co | Olean. |
| B. T. Fairchild & Co | Portville. |
| E. F. Gervitz | West Valley. |

### TANKS AND SILOS.

| | |
|---|---|
| Carley Heater Co | Olean. |

### VEHICLES AND VEHICLE PARTS.

| | |
|---|---|
| E. F. Smith | Allegany. |
| E. D. Satterlee | East Otto. |
| S. R. Sikes & Son | East Otto. |
| Gowanda Pump Works | Gowanda. |
| New Conklin Wagon Co | Olean. |
| B. T. Fairchild | Portville. |

### WOODENWARE AND NOVELTIES.

| | |
|---|---|
| Delevan Mfg. Co | Delevan. |

## CAYUGA COUNTY.

### AGRICULTURAL IMPLEMENTS.

| | |
|---|---|
| International Harvester Co | Auburn. |
| Quick & Thomas Co | Auburn. |
| Evarts Mfg. Co | Meridian. |
| David R. Wagner | Meridian. |

### BASKETS AND FRUIT PACKAGES.

| | |
|---|---|
| George O. Bennett | Ira Station. |
| John Rafferty | King Ferry. |
| D. R. Fuller | Springlake. |

### BOAT AND SHIP.

| | |
|---|---|
| Cayuga Motor Boat Co | Cayuga. |
| H. F. Tanner | Port Byron. |
| The Abram Walrath Co | Weedsport. |

## CAYUGA COUNTY — (Continued).

### BOXES AND CRATES, PACKING.

Henry & Allen .................................. Auburn.
David Wadsworth & Son .......................... Auburn.
The Abram Walrath Co ........................... Weedsport.

### FURNITURE.

Auburn State Prison ............................ Auburn.

### HANDLES.

Cady Mfg. Co ................................... Auburn.
R. B. Baker .................................... Merrifield.

### INSTRUMENTS, MUSICAL.

Wegman Piano Co ................................ Auburn.

### PLANING MILL PRODUCTS

Clark Lumber Co ................................ Auburn.
E. B. & H. J. Koon ............................. Auburn.
Luke Williams .................................. Auburn.
H. B. Livermore ................................ Dresserville.
Ralph L. Teeter ................................ Moravia.
The Abram Walrath Co ........................... Weedsport.

### PUMPS.

L. Curren & Son ................................ Spring Lake.

### SASH, DOORS, BLINDS, GENERAL MILL WORK.

John L. Alnutt ................................. Auburn.
L. R. Carl ..................................... Auburn.
Ralph L. Teeter ................................ Moravia.

### TANKS AND SILOS.

The Abram Walrath Co ........................... Weedsport.

### VEHICLES AND VEHICLE PARTS.

Eagle Wagon Works .............................. Auburn.
George F. Wills ................................ Auburn.
E. Q. Dutton & Co .............................. Cato.
E. Kennedy ..................................... Cato.
Blaisdell-Sperry Mfg. Co ....................... Martville.
Evarts Mfg. Co ................................. Meridian.
David R. Wagner ................................ Meridian.
G. S. Cady & Co ................................ Moravia.
The Abram Walrath Co ........................... Weedsport.

# CHAUTAUQUA COUNTY.

## AGRICULTURAL IMPLEMENTS.

F. W. Anderson........ Portland.

## BASKETS AND FRUIT PACKAGES.

Crandall Panel Co........ Brocton.
B. Landers & Son........ Cassadaga.
Hartfield Veneer Mill........ Hartfield.
G. H. Upton........ Hartfield.
W. H. Bagley........ Niobe.
Alfred Darling........ North Clymer.
W. E. Dudley........ Portland.
W. F. Royce........ Ripley.
W. B. Rickenbrode........ Ripley.
C. E. Cobb........ Sherman.
Arthur C. Angrom........ Silver Creek.
Harry Ehmke........ Silver Creek.
Frederickson & Bussing........ Stockton.
B. O. Taylor........ Stockton.
Falvay Bros. Basket Co........ Westfield.

## BOAT AND SHIP BUILDING.

Mandus Peterson........ Celoron.
Carter & Son........ Jamestown.
Est. of John T. Wilson........ Jamestown.

## BOXES AND CRATES, PACKING.

Brocton Furniture Co........ Brocton.
L. Knott & Co........ Cassadaga.
American Mfg. Concern........ Falconer.
E. J. Turk........ Fredonia.
The Blackstone Mfg. Co........ Jamestown.
Cadwell Cabinet Co........ Jamestown.
Dahlstrom Metallic Door Co........ Jamestown.
Elite Furniture Co........ Jamestown.
Empire Case Goods Co........ Jamestown.
Globe Cabinet Co........ Jamestown.
Himebaugh Bros........ Jamestown.
Jamestown Table Co........ Jamestown.
Maddox Table Co........ Jamestown.
Marvel Furniture Co........ Jamestown.
Seaburg Mfg. Co........ Jamestown.
Shearman Bros. Co........ Jamestown.
Star Furniture Co........ Jamestown.
Watson Mfg. Co........ Jamestown.
A. J. Hempel........ Silver Creek.
Huntley Mfg. Co........ Silver Creek.
Invincible Grain Cleaner Co........ Silver Creek.
H. J. Montgomery Mfg. Co........ Silver Creek.
D. N. Morse........ Westfield.

## CAR CONSTRUCTION.

American Locomotive Co........ Dunkirk.

## CHAUTAUQUA COUNTY — (Continued).

### CHAIRS.

Jamestown Chair Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Jamestown Lounge Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Shearman Bros. Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Peter Koford . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Silver Creek.
H. J. Montgomery Mfg. Co. . . . . . . . . . . . . . . . . . . . . . . . . Silver Creek.

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES

W. F. Stetson Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Cherry Creek.
American Mfg. Concern. . . . . . . . . . . . . . . . . . . . . . . . . . . Falconer.
Edward L. Gossett . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.

### FIXTURES.

Nelson Bros . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.

### FURNITURE.

Brocton Furniture Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . Brocton.
American Mfg. Concern. . . . . . . . . . . . . . . . . . . . . . . . . . . Falconer.
Supreme Furniture Mfg. Co. . . . . . . . . . . . . . . . . . . . . . . . Falconer.
Alliance Furniture Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Anchor Furniture Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Atlas Furniture Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Bailey Table Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
The F. M. Curtis Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Diamond Furniture Co. . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Eagle Furniture Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Eckman Furniture Co. . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Elite Furniture Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Elk Furniture Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Empire Case Goods Co. . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Globe Cabinet Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Ed. L. Gossett . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Hemick Mfg. Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Himebaugh Bros . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Ideal Furniture Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Jamestown Cabinet Co. . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Jamestown Lounge Co. . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Jamestown Table Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Level Furniture Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Maddox Table Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Marvel Furniture Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
National Furniture Co. . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Nelson & Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
A. C. Norquist Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Peerless Furniture Co. . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
H. P. Robertson Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Seabury Mfg. Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Shearman Bros. Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Standard Table Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Star Furniture Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Superior Furniture Co. . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Union Furniture Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Chautauqua Cabinet Co. . . . . . . . . . . . . . . . . . . . . . . . . . Mayville.
Peter Koford . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Silver Creek.

## CHAUTAUQUA COUNTY — (Continued).

### HANDLES.

| | |
|---|---|
| Lindblad Bros | Jamestown. |
| C. E. Cobb | Sherman. |

### INSTRUMENTS, MUSICAL.

| | |
|---|---|
| Ahlstrom Piano Co | Jamestown. |
| C. W. Herrick Mfg. Co | Jamestown. |

### INSTRUMENTS, PROFESSIONAL.

| | |
|---|---|
| American Mfg. Concern | Falconer. |

### LAUNDRY APPLIANCES.

| | |
|---|---|
| Blackstone Mfg. Co | Jamestown. |

### MACHINE CONSTRUCTION.

| | |
|---|---|
| Lindblad Bros. Co | Jamestown. |
| Huntley Mfg. Co | Silver Creek. |
| Invincible Grain Cleaner Co | Silver Creek. |
| The S. Howes Co | Silver Creek. |

### MACHINERY AND ELECTRICAL APPARATUS.

| | |
|---|---|
| Cadwell Cabinet Co | Jamestown. |
| Lindblad Bros. Co | Jamestown. |

### PLANING MILL PRODUCTS.

| | |
|---|---|
| G. Fardink & Son | Ashville. |
| Green Bros | Ashville. |
| Brocton Hardware and Lumber Co | Brocton. |
| L. Knott & Co | Cassadaga. |
| C. E. Hess | Cherry Creek. |
| Clymer Door, Sash and Lumber Co | Clymer. |
| Madigan Lumber Co | Dunkirk. |
| O'Donnell Lumber Co | Dunkirk. |
| J. H. Taylor | Dunkirk. |
| C. J. Main | Ellington. |
| M. H. Terry | Ellington. |
| Jamestown Marble Co | Falconer. |
| L. F. Swartz | Findley Lake. |
| Sly & Coddington | Fredonia. |
| Caflish Bros | Jamestown. |
| Charles Lindbeck | Jamestown. |
| Nelson Bros | Jamestown. |
| Pearl City Veneer Co | Jamestown. |
| Estate of John T. Wilson | Jamestown. |
| Nichols Bros | Kennedy. |
| A. H. Reed | North Clymer. |
| Garrison & Peck | Ripley. |
| Fred Briggs | Sinclairville. |
| S. Littlefield | Sinclairville. |
| Westfield Lumber and Coal Co | Westfield. |

**CHAUTAUQUA COUNTY — (Continued).**

PULLEYS AND CONVEYORS.

Huntley Mfg. Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Silver Creek.

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Crandall Panel Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Brocton.
Brocton Hardware and Lumber Co. . . . . . . . . . . . . . . . Brocton.
L. Knott & Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Cassadaga.
Clymer Door, Sash and Lumber Co. . . . . . . . . . . . . . . . Dunkirk.
Madigan Lumber Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . Dunkirk.
O'Donnell Lumber Co. . . . . . . . . . . . . . . . . . . . . . . . . . . Dunkirk.
Jamestown Mantel Co. . . . . . . . . . . . . . . . . . . . . . . . . . . Falconer.
John Luke . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Fredonia.
Sackett Screen Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Fredonia.
Sly & Coddington. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Fredonia.
American Carving Works. . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Jamestown Window Screen Co. . . . . . . . . . . . . . . . . . . Jamestown.
Munson & Johnson. . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Nelson Bros. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Watson Mfg. Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Estate of John T. Wilson. . . . . . . . . . . . . . . . . . . . . . . . Jamestown.
Nichols Bros. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Kennedy.

ROLLERS, SHADE AND MAP.

Westfield Lumber and Coal Co. . . . . . . . . . . . . . . . . . . Westfield.

TANKS AND SILOS.

Green Bros. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Ashville.
L. Knott & Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Cassadaga.

VEHICLES.

The Mulholland Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . Dunkirk.
Salisbury Wheel and Mfg. Co. . . . . . . . . . . . . . . . . . . . Jamestown.
A. J. Hemple. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Silver Creek.
D. J. Van Vlack. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Silver Creek.

WOODENWARE AND NOVELTIES.

Edward L. Gassett . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Jamestown.

## CHEMUNG COUNTY.

AGRICULTURAL IMPLEMENTS.

Field Force Pump Co. . . . . . . . . . . . . . . . . . . . . . . . . . . Elmira.

BASKETS AND FRUIT PACKAGES.

H. B. Harding. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Breesport.
John Horton . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Horseheads.

BOXES, CIGAR.

F. M. Howell & Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . Elmira.

## CHEMUNG COUNTY — (Continued).

### BOXES AND CRATES, PACKING.

American-LaFrance Fire Engine Co. . . . . . . . . . . . . . . . Elmira.
Diven Mfg. Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . Elmira.
Eureka Molding Co. . . . . . . . . . . . . . . . . . . . . . . . . . Elmira Heights.
Field Force Pump Co. . . . . . . . . . . . . . . . . . . . . . . . Elmira Heights.
Elmira Table Mfg. Co. . . . . . . . . . . . . . . . . . . . . . . . Elmira Heights.

### CAR CONSTRUCTION.

Northern Central Railway Co. . . . . . . . . . . . . . . . . . . . Elmira.

### CASKETS AND COFFINS.

Elmira Door and Supply Co. . . . . . . . . . . . . . . . . . . . . Elmira.

### EXCELSIOR.

E. M. Blystone . . . . . . . . . . . . . . . . . . . . . . . . . . . Elmira.

### FURNITURE.

M. H. Humphrey . . . . . . . . . . . . . . . . . . . . . . . . . . . Breesport.
J. Allington & Son . . . . . . . . . . . . . . . . . . . . . . . . . Elmira.
Diven Mfg. Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . Elmira.
Elmira Table Mfg. Co. . . . . . . . . . . . . . . . . . . . . . . . Elmira Heights.

### PLANING MILL PRODUCTS.

Doane & Jones Lumber Co. . . . . . . . . . . . . . . . . . . . . . Elmira.
Harris, McHenry & Baker Co. . . . . . . . . . . . . . . . . . . . Elmira.
Charles Newton . . . . . . . . . . . . . . . . . . . . . . . . . . . Elmira.
Verne Wells . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Elmira.
J. N. Wood & Co. . . . . . . . . . . . . . . . . . . . . . . . . . . Elmira.
Young Lumber Co. . . . . . . . . . . . . . . . . . . . . . . . . . . Elmira.
John R. Jump . . . . . . . . . . . . . . . . . . . . . . . . . . . . Elmira.
W. E. Tuttle Lumber Co. . . . . . . . . . . . . . . . . . . . . . . Horseheads.
Arthur Dense . . . . . . . . . . . . . . . . . . . . . . . . . . . . Swartwood.
L. L. Briggs . . . . . . . . . . . . . . . . . . . . . . . . . . . . Van Etten.

### PUMPS.

Eastern Mfg. Co. . . . . . . . . . . . . . . . . . . . . . . . . . . Elmira.
A. Wyckoff & Son Co. . . . . . . . . . . . . . . . . . . . . . . . . Elmira.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Harris, McHenry & Baker . . . . . . . . . . . . . . . . . . . . . . Elmira.
Kertscher & Co., Inc. . . . . . . . . . . . . . . . . . . . . . . . Elmira.
H. C. Spaulding Co. . . . . . . . . . . . . . . . . . . . . . . . . . Elmira.

### VEHICLES.

American-LaFrance Fire Engine Co. . . . . . . . . . . . . . . . Elmira.
John T. Ayres . . . . . . . . . . . . . . . . . . . . . . . . . . . . Elmira.
John Horton . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Horseheads.

## CHENANGO COUNTY.

### AGRICULTURAL IMPLEMENTS.

Lyons Iron Works.......... Greene.

### BASKETS AND FRUIT PACKAGES.

Oxford Basket and Mfg. Co.......... Oxford.

### BOXES AND CRATES, PACKING.

W. R. Prouty.......... Bainbridge.
Camp Bros. Mfg. Co.......... New Berlin.
B. F. Gladding & Co.......... So. Otselic.

### CAR CONSTRUCTION.

S. N. Skinner.......... Rockdale.

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

J. E. Gould.......... Greene.
Lyons Iron Works.......... Greene.
Will C. Andrus.......... Pitcher.

### FURNITURE.

Greene Mfg. Co., Ltd.......... Greene.
George Wheeler.......... Norwich.
F. K. Hallett.......... Smithville.
J. C. McMillan.......... So. Otselic.

### PATTERNS AND FLASKS.

Lyons Iron Works.......... Greene.

### PLANING MILL PRODUCTS.

W. R. Prouty.......... Bainbridge.
W. A. Robinson.......... Brisbane.
J. E. Gould.......... Greene.
Lyons Iron Works.......... Greene.
J. S. Tripp.......... Guilford.
William Fleming.......... McDonough.
H. L. Crain.......... Mt. Upton.
E. J. Elliott.......... Norwich.
W. L. Scott Lumber Co.......... Norwich.
George Wheeler.......... Norwich.
A. J. Beardsley.......... Pitcher.
G. W. Bennett.......... Pitcher.
Charles H. Church.......... Oxford.
S. N. Skinner & Son.......... Rockdale.
Nathaniel Bagg.......... So. New Berlin.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

W. R. Prouty.......... Bainbridge.
W. L. Scott Lumber Co.......... Norwich.
A. J. Beardsley.......... Pitcher.
J. C. McMillan.......... So. Otselic.

**CHENANGO COUNTY — (Continued).**

SPORTING AND ATHLETIC GOODS.

B. F. Gladding & Co .......... So. Otselic.

TANKS AND SILOS.

W. L. Scott Lumber Co .......... Norwich.

VEHICLES, ETC.

B. H. Norton .......... Bainbridge.
W. R. Prouty .......... Bainbridge.
S. N. Skinner & Son .......... Rockdale.

WOODENWARE AND NOVELTIES.

George Wheeler .......... Norwich.

## CLINTON COUNTY.

BOXES AND CRATES, PACKING.

Clinton Prison .......... Dannemora.
Lozier Motor Co .......... Plattsburg.
Millard Lumber Co .......... Rouses Point.

CHAIRS.

Clinton Prison .......... Dannemora.

EXCELSIOR.

F. E. Sheffield .......... Mooers.
George H. Carroll & Co .......... Plattsburg.

PATTERNS AND FLASKS.

Lozier Motor Co .......... Plattsburg.

PLANING MILL PRODUCTS.

F. E. Purly .......... Altona.
J. L. Carter .......... Ellenburg.
E. C. Hobbs & Son .......... Ellenburg Center.
A. Mason & Sons .......... Peru.
Plattsburg Lumber Co .......... Plattsburg.

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

John Earl .......... Champlain.
Clinton Prison .......... Dannemora.
R. J. Remie .......... Mooers Forks.
A. Mason & Sons .......... Peru.
The LaCroix Sash and Door Co .......... Plattsburg.

## COLUMBIA COUNTY.

### AGRICULTURAL IMPLEMENTS.

L. R. Loomis.......... Claverack.
Columbia Plow Works.......... Copake Falls.
Hillsdale Plow Co.......... Hillsdale.

### BASKETS AND FRUIT PACKAGES.

M. Tinkelpaugh.......... Kinderhook.

### CIGAR BOXES.

Philip Fehl.......... Hudson.

### BOXES AND CRATES, PACKING.

Louis Winstran.......... Hudson.
J. P. Mfg. Co.......... Niverville.

### CHAIRS.

Louis Winstran.......... Hudson.
R. M. Wagon & Co.......... Mt. Lebanon.

### EQUIPMENT, PLAYGROUND.

E. D. Shaver.......... Niverville.

### FURNITURE.

Louis Winstran.......... Hudson.

### MACHINERY AND APPARATUS, ELECTRICAL.

J. P. Mfg. Co.......... Niverville.

### PATTERNS AND FLASKS.

E. D. Shaver.......... Niverville.

### PLANING MILL PRODUCTS.

T. S. Buckley & Son.......... Chatham.
Thomas L. Hayes.......... E. Chatham.
Jacob Henderson.......... Columbiaville.
L. C. Felpel.......... Ghent.
D. H. Weaver.......... Glenco Mills.
Robert Westover.......... Hillsdale.
D. Van Alstyne & Sons.......... Stuyvesant.

### PUMPS.

Robert Hoes.......... Malden Bridge.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

J. T. Winfield.......... Germantown.
Charles W. Macy.......... Hudson.
William H. Traver & Son.......... Hudson.
L. H. Weaver.......... Hudson.

### SPORTING AND ATHLETIC GOODS.

Koones & Co.......... Livingston.

### VEHICLES.

Peter Swab.......... Chatham.
The Sibley Co.......... Hudson.

### WOODENWARE AND NOVELTIES.

J. R. Davis.......... Niverville.


Steaming staves being rolled out on trucks and piled under sheds. Over 50,000,000 staves are made annually in New York for slack cooperage used in the shipment of apples and other fruit, cement, vegetables, crockery, sugar, flour, etc. The principal woods used are birch, beech, maple, elm, spruce and ash. Photograph taken at the plant of the Brooklyn Cooperage Co. at Faust, N. Y. Photograph by Nelson C. Brown.

## CORTLAND COUNTY.

### BOXES AND CRATES, PACKING.

Cortland Cabinet Co. . . . . . . . Cortland.
Cortland Carriage Goods Co . . . . . . . . Cortland.
Wickwire Bros., Inc . . . . . . . . Cortland.
W. A. Perkins . . . . . . . . Harford Mills.
Central Paper Box Co . . . . . . . . McGraw.
McGraw Mfg. Co. . . . . . . . . McGraw.

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

Meldrim Bros. . . . . . . . . Cincinnatus.
G. M. Watson . . . . . . . . Cortland.
Meldrim Bros. . . . . . . . . Truxton.

### FURNITURE.

Cortland Cabinet Co . . . . . . . . Cortland.
Homer Table Works. . . . . . . . . Homer.
Bryant Furniture Co . . . . . . . . Truxton.

### HANDLES.

Herbert R. Greenman. . . . . . . . . McGraw.

### MACHINE CONSTRUCTION.

Wickwire Bros., Inc . . . . . . . . Cortland.
Climax Road Machine Co . . . . . . . . Marathon.

### PLANING MILL PRODUCTS.

James H. Moore . . . . . . . . Cincinnatus.
H. F. Benton Lumber Co . . . . . . . . Cortland.
Bush & Glover . . . . . . . . Cortland.
Charles S. Brown . . . . . . . . Homer.
N. Berry . . . . . . . . Taylor.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

H. F. Benton Lumber Co . . . . . . . . Cortland.
Bush & Glover . . . . . . . . Cortland.

### VEHICLES AND VEHICLE PARTS.

H. F. Benton Lumber Co . . . . . . . . Cortland.
Cortland Carriage Goods Co . . . . . . . . Cortland.
W. H. Newton & Son . . . . . . . . Cortland.
W. M. Brockway . . . . . . . . Homer.

## DELAWARE COUNTY.

### BOOT AND SHOE FINDINGS.

E. S. Sikes & Co.......... Downsville.

### BOXES AND CRATES, PACKING.

Hanford Bros.......... East Meredith.

### BRUSHES AND BROOMS.

Cadosia Mfg. Co.......... Cadosia.
H. A. Williams.......... Sidney.

### CHAIRS.

B. G. Harrison Mfg. Co.......... Arkville.
Sidney Novelty Co.......... Hancock.

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

G. D. Dudley.......... Roxbury.
G. A. Clark & Co.......... Sidney.

### EXCELSIOR.

East Branch Excelsior Co.......... East Branch.
J. K. Hornbeck & Co.......... Hancock.

### FIXTURES.

Sidney Novelty Co.......... Sidney.

### FURNITURE.

Sidney Novelty Co.......... Sidney.

### HANDLES.

Cadosia Mfg. Co.......... Cadosia.

### MUSICAL INSTRUMENTS.

Herbert A. Burlingame.......... Walton.

### LAUNDRY APPLIANCES.

Sidney Novelty Co.......... Sidney.

### PLANING MILL PRODUCTS.

A. H. Pierson.......... Apex.
E. W. Gillett.......... Cannonville.
Hanford Bros.......... East Meredith.
W. Cronk.......... Grand Gorge.
Crosby Kelly.......... Griffin Corners.
Walter Morley.......... Hancock.
T. F. Stimpson.......... Hancock.
Van Buren & Conkling.......... Hobart.
Margaretville Planing Mill.......... Margaretville.
Victor Epps.......... North Franklin.
Bartlett Bros.......... Pepacton.
Cox Bros.......... Union Grove.
L. Roy Jenkins.......... Union Grove.
Coleman & Jones.......... Walton.

**DELAWARE COUNTY — (Continued).**

PRINTING MATERIAL.

Sidney Novelty Co. . . . . . . . . . Sidney.

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Berry & Benedict. . . . . . . . . . Franklin.
W. Cronk . . . . . . . . . . Grand Gorge.
Crosby Kelly . . . . . . . . . . Griffin Corners.
G. A. Clark & Co. . . . . . . . . . Sidney.
Delaware Valley Feed and Lumber Co. . . . . . . . . . Stamford.

TOYS.

Walton Toy Co. . . . . . . . . . Walton.

VEHICLES AND VEHICLE PARTS.

Charles L. Huber. . . . . . . . . . Delhi.
J. Klein & Co. . . . . . . . . . Hancock.
Cortland Cart and Carriage Co. . . . . . . . . . Sidney.
Albert Smith . . . . . . . . . . Walton.
Walton Foundry Co. . . . . . . . . . Walton.

WOODENWARE AND NOVELTIES.

S. W. Brown. . . . . . . . . . Pepacton.
Sidney Novelty Co. . . . . . . . . . Sidney.
W. S. Cure. . . . . . . . . . Stamford.

## DUTCHESS COUNTY.

AGRICULTURAL IMPLEMENTS.

Adriance Platt & Co. . . . . . . . . . Poughkeepsie.
Anchor Bolt and Nut Co. . . . . . . . . . Poughkeepsie.

BOAT AND SHIP BUILDING.

Robert R. Albertson. . . . . . . . . . New Hamburg.

BOXES AND CRATES, PACKING.

Willson & Eaton Co. . . . . . . . . . Amenia.
Dutchess Hat Works. . . . . . . . . . Fishkill.
Dutchess Tool Co. . . . . . . . . . Fishkill.
William Carroll & Co. . . . . . . . . . Matteawan.
Green Fuel Economizer Co. . . . . . . . . . Matteawan.
Matteawan Mfg. Co. . . . . . . . . . Matteawan.
Anchor Bolt and Nut Co. . . . . . . . . . Poughkeepsie.
DeLaval Separator Machine Co. . . . . . . . . . Poughkeepsie.
Garner Print Works and Bleachers. . . . . . . . . . WappingersFalls.

CHAIRS.

The Chichester Bros. Chair Co. . . . . . . . . . Poughkeepsie.
Kall Rock Chair Co. . . . . . . . . . Poughkeepsie.
Poughkeepsie Chair Co. . . . . . . . . . Poughkeepsie.

DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

The DeLaval Cream Separator Machine Co. . . . . . . . . . Poughkeepsie.
Lown & Son. . . . . . . . . . Poughkeepsie.

## DUTCHESS COUNTY — (Continued).

### MACHINE CONSTRUCTION.

Green Fuel Economizer Co........................ Matteawan.

### PATTERNS AND FLASKS.

Robert J. & T. H. Stewart........................ New Hamburg.

### PLANING MILL PRODUCTS.

A. C. Toof.................................... Rhinebeck.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Willson & Eaton Co............................ Amenia.
Swift Bros.................................... Millbrook.
Brooks & Co................................... Poughkeepsie.
Levi Lumb's Sons.............................. Poughkeepsie.
New York Portable Bungalow Co................. Poughkeepsie.

### VEHICLES AND VEHICLE PARTS.

Peattie Bros.................................. Fishkill.
S. D. Jackson................................. Matteawan.
F. I. A. T.................................... Poughkeepsie.
Thomas McWhennie ............................. Poughkeepsie.
Reed & Forman................................. Poughkeepsie.

### WOODENWARE AND NOVELTIES.

Thomas McWhennie ............................. Poughkeepsie.

## ERIE COUNTY.

### AGRICULTURAL IMPLEMENTS.

Buffalo Pitts Co.............................. Buffalo.

### BASKET AND FRUIT PACKAGES.

Eden Planing Mill Co.......................... Eden Centre.

### BOATS AND SHIPS.

R. W. Savage & Son............................ Akron.
John O'Day ................................... Buffalo.
Buffalo Dry Dock Co........................... Buffalo.
H. R. Savage.................................. East Aurora and Wales Center.
Edwin I. Rose................................. Tonawanda.
W. H. Fallett................................. Tonawanda.

### BOOT AND SHOE FINDINGS.

The O'Dell & Eddy Co.......................... Chaffee.

## ERIE COUNTY — (Continued).

### BOXES AND CRATES, PACKING.

| | |
|---|---|
| Milford Calkins | Brant. |
| American Radiator Co. | Buffalo. |
| American Seating Co. | Buffalo. |
| M. J. Bernhard | Buffalo. |
| Buffalo Lounge Co. | Buffalo. |
| Buffalo Radiator Co. | Buffalo. |
| Cutler Desk Co. | Buffalo. |
| Cutting Furniture Co. | Buffalo. |
| Cyphers Incubator Co. | Buffalo. |
| A. Dutch & Co. | Buffalo. |
| Eagle Printing Ink Co. | Buffalo. |
| G. Elias & Bro. | Buffalo. |
| Robert Essex Incubator Co. | Buffalo. |
| Graves, Maubert, George & Co. | Buffalo. |
| Heinz & Munschauer | Buffalo. |
| Hill Mfg. Co. | Buffalo. |
| William J. Hines, Jr. | Buffalo. |
| Jacob Jaeckle Furniture Co. | Buffalo. |
| C. Kurtzman & Co. | Buffalo. |
| MacLean Box Factory | Buffalo. |
| McKinnon Dash Co. | Buffalo. |
| Niagara Box Co. | Buffalo. |
| Pierce-Arrow Motor Car Co. | Buffalo. |
| Pratt & Leftwich Co. | Buffalo. |
| Adam Sauer | Buffalo. |
| Sikes Chair Co. | Buffalo. |
| Steul & Thurman Co. | Buffalo. |
| W. P. Taylor & Co. | Buffalo. |
| O'Dell & Eddy Co. | Chaffee. |
| Hamburg Planing Mill Co. | Hamburg. |
| Holland Planing Mill Co. | Holland. |
| Lancaster Machine and Knife Co. | Lancaster. |
| J. A. Falk | North Collins. |
| Orchard Park Planing Mill | Orchard Park. |
| Wilson Lumber and Box Co. | Tonawanda. |
| E. R. Thomas Motor Car Co. | Buffalo. |
| M. Zeis & Sons | Buffalo. |

### CIGAR BOXES.

| | |
|---|---|
| Charles Reisterholz | Buffalo. |
| Adam Sauer | Buffalo. |

### BRUSHES AND BROOMS.

| | |
|---|---|
| L. Noillers Sons | Buffalo. |
| H. R. Savage | E. Aurora. |

### CAR CONSTRUCTION.

| | |
|---|---|
| American Car and Foundry Co. | Buffalo. |
| Pennsylvania Railroad Co. | Buffalo. |
| Pullman Co. | Buffalo. |

**ERIE COUNTY** — (Continued).

CASKETS.

Central Casket Co.................................. Buffalo.

CHAIRS.

Buffalo Chair Works.................................. Buffalo.
Hill Mfg. Co.................................. Buffalo.
Sikes Chair Co.................................. Buffalo.

DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

Carl W. Savage.................................. Alden.
R. W. Savage & Son.................................. Akron.
Robert Essex Incubator Co.................................. Buffalo.
Cyphers Incubator Co.................................. Buffalo.
C. W. Kellogg.................................. Springville.
H. R. Savage.................................. East Aurora and Wales Center.

DOWELS.

Charles Rohlfs .................................. Buffalo.

ELEVATORS.

C. W. Smith.................................. Buffalo.
Otis Elevator Co.................................. Buffalo.

FIREARMS.

G. Elias & Bro.................................. Buffalo.

FIXTURES.

American Seating Co.................................. Buffalo.
M. J. Bernhard.................................. Buffalo.
A. Dutch & Co.................................. Buffalo.
H. W. Kruse.................................. Buffalo.
Charles Rohlfs .................................. Buffalo.

FRAMES AND MOULDINGS.

Henry G. White.................................. Buffalo.

FURNITURE.

George Brown .................................. Akron.
Bison City Table Co.................................. Buffalo.
Blecher & Kratz.................................. Buffalo.
Buffalo Lounge Co.................................. Buffalo.
Colie & Son.................................. Buffalo.
Cutler Desk Co.................................. Buffalo.
Cutting Furniture Co.................................. Buffalo.
Jacob Jaeckle Furniture Co.................................. Buffalo.
Stuhlmiller Mantel Works.................................. Buffalo.
L. Noeller's Sons.................................. Buffalo.
Steul & Phuman Co.................................. Buffalo.
Charles Rohlfs .................................. Buffalo.
Roycrorters .................................. East Aurora.

## ERIE COUNTY — (Continued).

### HANDLES.

| | |
|---|---|
| Jackson & Tindle | Buffalo. |
| E. B. Trank | Holland. |

### INSTRUMENTS, MUSICAL.

| | |
|---|---|
| Chase & Baker Co | Buffalo. |
| C. Kurtman & Co. | Buffalo. |
| Viner & Son | Buffalo. |
| Wood & Brooks Co | Buffalo. |

### INSTRUMENTS, PROFESSIONAL.

| | |
|---|---|
| R. H. Hoyt | Buffalo. |
| Henry Salzler | Springville. |
| Tonawanda Advertising Co. | Tonawanda. |

### LAUNDRY APPLIANCES.

| | |
|---|---|
| Gilroy Stretcher Co | Buffalo. |
| R. H. Hoyt | Buffalo. |
| J. D. Russ & Co | Buffalo. |

### MACHINE CONSTRUCTION.

| | |
|---|---|
| C. O. Tinkham | Akron. |

### MACHINERY AND APPARATUS, ELECTRICAL.

| | |
|---|---|
| Buffalo Tel. Const. Co | Buffalo. |
| Wilhelm & Koehler Electrotype Co | Buffalo. |

### PATTERNS AND FLASKS.

| | |
|---|---|
| Charles Rohlfs | Buffalo. |
| W. P. Taylor Co | Buffalo. |

### PLANING MILL PRODUCTS.

| | |
|---|---|
| L. Belger | Akron. |
| Lewis Wurtz | Boston. |
| Batavia and New York Wood Working Co | Buffalo. |
| Buffalo Planing Mill Co | Buffalo. |
| Christian Flierl | Buffalo. |
| Dohn, Fisher & Beyer | Buffalo. |
| East Buffalo Mill and Lumber Co | Buffalo. |
| G. Elias & Bros | Buffalo. |
| John Feist & Sons Co | Buffalo. |
| John E. Grenzebach | Buffalo. |
| E. M. Hager & Sons Co | Buffalo. |
| William Heinrich's Sons Co | Buffalo. |
| Hurd Bros | Buffalo. |
| Lindsay Floor Co | Buffalo. |
| Montgomery Bros. Co | Buffalo. |
| William Neubecker | Buffalo. |
| George A. Norton, Jr | Buffalo. |
| George F. Sowerby | Buffalo. |
| M. Zeis & Sons | Buffalo. |
| Miller Bros | Colden. |

**ERIE COUNTY** — (Continued).

PLANING MILL PRODUCTS.

Johengen, Johnson & Schmitz.................... Collins Center.
W. H. Geib.................................... East Aurora.
S. H. Peck..................................... East Aurora.
Eden Planing Mill Co............................ Eden Center.
Hamburg Planing Mill Co........................ Hamburg.
West Seneca Lumber Co.......................... LackawannaCity.
George W. Safford............................. Lancaster.
Fred Lindlow, Sr............................... North Collins.
Orchard Park Planing Mill Co.................... Orchard Park.
John Z. Teal.................................... Orchard Park.
George Herbold ................................. Springville.
Henry Salzler ................................. Springville.
L. J. Shuttleworth.............................. Springville.
A. T. Wheeler................................... Springville.
C. J. Wilk & Co................................ Tonawanda.

PLUMBERS' WOOD WORK.

Buffalo Bath Cabinet Co......................... Buffalo.

PRINTING MATERIALS.

Buffalo Engraving Co............................ Buffalo.
Wilhelm & Koehler Electrotype Co................ Buffalo.

REFRIGERATORS AND KITCHEN CABINETS.

Heinz & Munschauer.............................. Buffalo.
Jacob Jaeckle Furniture Co...................... Buffalo.
Jewett Refrigerator Co.......................... Buffalo.
P. A. Vogt Mfg. Co.............................. Buffalo.
Orchard Park Planing Mill Co.................... Orchard Park.

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

L. Belger ...................................... Akron.
George Brown ................................... Akron.
W. M. Sheflin................................... Angola.
Charles Boller & Sons Co........................ Buffalo.
Buffalo Grill Co................................ Buffalo.
Buffalo Mantel Mfg. Co.......................... Buffalo.
Dohn, Fisher & Beyer............................ Buffalo.
G. Elias & Bros................................. Buffalo.
Christian Flierl ............................... Buffalo.
J. E. Granzeback................................ Buffalo.
E. M. Hager & Sons Co........................... Buffalo.
John W. Jones................................... Buffalo.
Montgomery Bros. Co............................. Buffalo.
William Neubecker .............................. Buffalo.
Pierce-Arrow Motor Car Co....................... Buffalo.
George F. Sowerby............................... Buffalo.
J. W. Slattery.................................. Buffalo.
Steul & Therman Co.............................. Buffalo.

ERIE COUNTY — (Continued).

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

| | |
|---|---|
| Stuhlmiller Mantel Works | Buffalo. |
| M. Zies & Sons | Buffalo. |
| George M. Zimmerman | Buffalo. |
| O'Dell & Eddy Co. | Chaffee. |
| Johengen, Johnson & Schwitz | Collins Center. |
| W. H. Geib | East Aurora. |
| S. H. Peck | East Aurora. |
| Eden Planing Mill Co | Eden Center. |
| H. A. Irmler | Gardenville. |
| Hamburg Planing Mill Co | Hamburg. |
| Home Lumber Co | Hamburg. |
| Holland Planing Mill Co | Holland. |
| West Seneca Lumber Co | Lackawanna City. |
| Jacob B. Oehm | Lancaster. |
| John V. Knauber | Lancaster. |
| Orchard Park Mill Co | Orchard Park. |
| George Herbold | Springville. |
| Henry Salzer | Springville. |
| L. J. Shuttleworth | Springville. |

SPORTING AND ATHLETIC GOODS.

| | |
|---|---|
| M. J. Bernhard | Buffalo. |
| William Dethloff | Buffalo. |

TANKS AND SILOS.

| | |
|---|---|
| S. H. Peck | East Aurora. |
| Holland Planing Mill Co. | Holland. |

TOYS.

| | |
|---|---|
| L. Moeller's Sons | Buffalo. |

TRUNKS AND VALISES.

| | |
|---|---|
| Bingham Trunk Co | Buffalo. |
| Buffalo Trunk Co | Buffalo. |
| R. H. Hoyt | Buffalo. |

VEHICLES, ETC.

| | |
|---|---|
| American Body Co | Buffalo. |
| Atterbury Motor Car Co. | Buffalo. |
| J. M. Blake & Son | Buffalo. |
| Bosche Bros | Buffalo. |
| Brunn's Carriage Mfg. Co | Buffalo. |
| Buffalo Auto Body and Trimming Co | Buffalo. |
| Buffalo Electric Vehicle Co | Buffalo. |
| Duchman Wagon Co. | Buffalo. |
| G. Elias & Bros | Buffalo. |
| Fisher & Kam | Buffalo. |
| Anthony J. Grad. | Buffalo. |
| C. J. Handel | Buffalo. |
| Henry Landshefts | Buffalo. |

ERIE COUNTY — (Continued).

VEHICLES, ETC.

| | |
|---|---|
| Peter Lesswing's Sons | Buffalo. |
| L. Noellis' Sons | Buffalo. |
| Pierce-Arrow Motor Car Co | Buffalo. |
| John F. Vogt | Buffalo. |
| Holland Planing Mill Co | Holland. |
| L. F. Tanner | Holland. |
| J. A. Falk | North Collins. |
| John J. Teal | Orchard Park. |

WOODENWARE AND NOVELTIES.

| | |
|---|---|
| Buffalo Pail and Barrel Co | Buffalo. |
| Holland Planing Mill Co | Holland. |
| Smith & Smith | Springville. |
| Tonawanda Advertising Co | Tonawanda. |

MISCELLANEOUS.

FIBRE BOARD.

| | |
|---|---|
| Beaver Co | Buffalo. |

HAMES.

| | |
|---|---|
| U. S. Hame Co | Buffalo. |

## ESSEX COUNTY.

BOAT AND SHIP BUILDING.

| | |
|---|---|
| George & Bliss | Lake Placid. |

BOXES AND CRATES, PACKING.

| | |
|---|---|
| G. F. Dudley & Co | Ticonderoga. |
| R. P. & L. R. Mead | Ticonderoga. |
| Scott E. Phinney | Wadhams. |

BRUSHES AND BROOMS.

| | |
|---|---|
| Robert Fisk | Crown Point Center. |

CHAIRS.

| | |
|---|---|
| Lobdell Bros | Elizabethtown. |
| H. C. Burnell | Westport. |

EXCELSIOR.

| | |
|---|---|
| Daniel Lynch | Minerva. |

FURNITURE.

| | |
|---|---|
| R. Prescott & Son | Keeseville. |
| C. A. Swan | Wadhams. |

HANDLES.

| | |
|---|---|
| Scott E. Phinney | Wadhams. |

## ESSEX COUNTY — (Continued).

### PLANING MILL PRODUCTS.

| | |
|---|---|
| Clarke & Parsons | Bloomingdale. |
| William J. McKittrick | Crown Point. |
| J. W. Phillips | Crown Point. |
| J. E. Pond & Son | Crown Point. |
| Almon O. Clark | Elizabethtown. |
| Lobdell Bros. | Elizabethtown. |
| C. C. Stafford | Essex. |
| F. S. Beede | Keene Valley. |
| Smith & Murray | Lake Placid. |
| Lake Placid Co. | Lake Placid. |
| E. A. Sargents | Lewis. |
| Witherbee, Sherman & Co. | Mineville. |
| H. D. Barton | Moriah Center. |
| Smith & Murray | Newman. |
| Augustus Lowry | Olmstedville. |
| Levi Bigelow | Port Henry. |
| H. A. Beede | Reber. |
| Schroon Lake Lumber Co. | Schroon Lake. |
| F. N. Tyrrell | Schroon Lake. |
| David Hunter | Tahawus. |
| R. P. & L. R. Mead | Ticonderoga. |
| S. B. Moore | Ticonderoga. |
| W. J. Smith Lumber Co. | Ticonderoga. |
| Nye Bros. | Upper Jay. |
| Scott E. Phinney | Wadhams. |
| C. C. Stafford | Whallonsburgh. |

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

| | |
|---|---|
| Lobdell Bros. | Elizabethtown. |
| R. Prescott & Son | Keeseville. |
| Lake Placid Co. | Lake Placid Club. |
| Witherbee, Sherman & Co. | Mineville. |
| L. H. Cross & Sons | Westport. |

### WOODENWARE AND NOVELTIES.

| | |
|---|---|
| Witherbee, Sherman & Co. | Mineville. |

## FRANKLIN COUNTY.

### BASKETS AND FRUIT PACKAGES.

| | |
|---|---|
| St. Regis Indian Trading Co. | Hogansburg. |

### BOXES AND CRATES, PACKING.

| | |
|---|---|
| William H. Plumb & Son | North Bangor. |
| Norwood Mfg. Co. | Tupper Lake. |

### CHAIRS.

| | |
|---|---|
| Frank Collins, Jr | Saranac. |

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

| | |
|---|---|
| B. L. Orcutt & Sons | Dickinson Center. |
| William S. Lawrence | Moira. |
| Peter Boardway | West Bangor. |

## FRANKLIN COUNTY — (Continued).

### EXCELSIOR.

| | |
|---|---|
| Chateaugay Excelsior Co | Chateaugay. |
| Globe Excelsior Co | Chateaugay. |
| Star Excelsior Co | Chateaugay. |
| Cantwell & Wilson | Malone. |
| Malone Excelsior Co | Malone. |

### FURNITURE.

| | |
|---|---|
| Frank Collins, Jr | Saranac. |

### PLANING MILL PRODUCTS.

| | |
|---|---|
| F. M. Hoy | Brainardsville. |
| C. L. Sancomb | Chateaugay. |
| B. L. Orcutt & Sons | Dickinson Center. |
| James Courtray | Fort Covington. |
| P. F. Keefe | Fort Covington. |
| E. O. Forbes | Fort Covington. |
| C. H. Dupree | Malone. |
| John Kelley | Malone. |
| The Malone Lumber Co | Malone. |
| Boyce Lumber Co | Owl's Head. |
| Paul Smith | Paul Smith's. |
| Reynolds Bros. & Co | Reynoldstown. |
| Branch & Callanan | Saranac Lake. |
| McKenna & Hamlin | Saranac Lake. |
| Upper Saranac Association | Upper Saranac. |
| F. H. Lyman | Whippleville. |
| William S. Lawrence | Moira. |

### ROLLERS.

| | |
|---|---|
| F. M. Hoy | Brainardsville. |

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

| | |
|---|---|
| C. H. Dupree | Malone. |
| Malone Lumber Co | Malone. |
| Smallman & Spencer | Malone. |
| George Webster Lumber Co | Malone. |
| Branch & Callanan | Saranac Lake. |
| F. C. Bowem | Skerry. |

### SPORTING AND ATHLETIC GOODS.

| | |
|---|---|
| W. H. Plumb | Malone. |
| William H. Plumb & Son | North Bangor. |

### TANKS AND SILOS.

| | |
|---|---|
| Adirondack Silo Co | Malone. |

### VEHICLES.

| | |
|---|---|
| L. W. Keeler & Sons | Bangor. |
| A. H. Flint | Moira. |

## FULTON COUNTY.

### BOXES AND CRATES, PACKING.

L. Stephenson .................................. Johnstown.
Younglove Lumber Co.......................... Johnstown.
William Vail's Sons.......................... Vail Mills.

### CHAIRS.

C. H. Trevett.................................. Broadalbin.
P. C. Trevett.................................. Broadalbin.

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

W. S. Sammons.................................. Johnstown.
T. J. Dugdale.................................. West Galway.

### DOWELS.

J. M. Peter's Sons.............................. Bleecker.

### FURNITURE.

Ellis & Smith.................................. Bleecker.
J. M. Peter's Sons.............................. Bleecker.
Everett Young .................................. Rockwood.

### HANDLES.

Ellis & Smith.................................. Bleecker.
J. M. Peter's Sons.............................. Bleecker.
Everett Young .................................. Rockwood.

### MUSICAL INSTRUMENTS.

Ellis & Smith.................................. Bleecker.

### LAUNDRY APPLIANCES.

Estate Sherman Tenant.......................... Northville.
H. & L. Tenant.................................. Northville.

### PLANING MILL PRODUCTS.

Ellis & Smith.................................. Bleecker.
Broadalbin Lumber Co.......................... Broadalbin.
Holden Lumber Co.............................. Gloversville.
Russell E. Holmes.............................. Gloversville.
L. Stephenson .................................. Johnstown.
Younglove Lumber Co.......................... Johnstown.
Estate of J. H. Smith.......................... Northampton.
Estate Sherman Tenant.......................... Northville.
John A. Willard................................ Northville.
William Vail's Sons.......................... Vail Mills.
William Gibson .................................. West Galway.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Holden Lumber Co.............................. Gloversville.
P. M. Simmons.................................. Johnstown.
Jonah Hess .................................... Johnstown.
W. S. Sammons.................................. Johnstown.
L. Stephenson .................................. Johnstown.
Stephenson & Newner.......................... Johnstown.
Younglove Lumber Co.......................... Johnstown.

**FULTON COUNTY — (Continued).**

VEHICLES AND VEHICLE PARTS.

L. Stephenson .................................... Johnstown.

## GENESEE COUNTY.

AGRICULTURAL IMPLEMENTS.

Batavia Machine Co.................................. Batavia.
The Johnson Harvester Co........................... Batavia.
Wiard Plow Co....................................... Batavia.
LeRoy Plow Co....................................... LeRoy.

BOXES AND CRATES, PACKING.

Johnson Harvester Co................................ Batavia.
Batavia and New York Wood Working Co.......... Batavia.
Wiard Plow Co....................................... Batavia.
M. E. True & Son.................................... East Pembroke.

DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

A. J. Kidder......................................... Darien Center.
F. C. Rogers......................................... LeRoy.

FURNITURE.

Wade & Uphill....................................... Batavia.

MACHINE CONSTRUCTION.

LeRoy Plow Co....................................... LeRoy.

PLANING MILL PRODUCTS.

Wade & Uphill....................................... Batavia.
J. Lapp ............................................. LeRoy.
F. C. Rogers......................................... LeRoy.

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Batavia and New York Wood Working Co.......... Batavia.
Wade & Uphill....................................... Batavia.
J. Lapp ............................................. LeRoy.
F. C. Rogers......................................... LeRoy.
Pavilion N. T. G. Co................................ Pavilion.

TANKS AND SILOS.

Batavia Machine Co.................................. Batavia.
F. C. Rogers......................................... LeRoy.

VEHICLES.

Batavia Machine Co.................................. Batavia.
M. E. True & Son.................................... East Pembroke.

WOODENWARE AND NOVELTIES.

K. B. Mathes Co...................................... Batavia.

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## GREENE COUNTY.

### BASKETS AND FRUIT PACKAGES.

George W. Dibble.............................. Elka Park.

### BOATS AND SHIPS.

Frank S. Howland.............................. Athens.
R. Lenahan .................................. Athens.

### BOXES AND CRATES, PACKING.

American Valve Co............................. Coxsackie.

### CHAIRS.

George W. Dibble.............................. Elka Park.
H. S. Lane................................... Lanesville.

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

Eugene Simpkins .............................. Freehold.

### PLANING MILL PRODUCTS.

Catskill Supply Co............................ Catskill.
John Frank ................................... Coxsackie.
H. E. Utter................................... East Durham.
George W. Dibble.............................. Elka Park.
L. M. Smith................................... Greenville.
Hitchcock & Haney............................. Hensonville.
W. H. Baldwin................................. New Baltimore.
C. D. Hallock................................. New Baltimore.
Adam Snyder .................................. Oak Hill.
Fred Butler .................................. Surprise.
Harvey A. Treesdall........................... West Coxsackie.
Seymour Ruggles .............................. Wilton.
W. E. Kelly................................... Windham.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

L. A. Miller.................................. Cairo.
Catskill Supply Co............................ Catskill.
George W. Dibble.............................. Elka Park.
J. H. Haney................................... Hensonville.
H. S. Lane.................................... Lanesville.
William J. Soper.............................. Windham.

### VEHICLES.

George W. Dibble.............................. Elka Park.
H. S. Lane.................................... Lanesville.

### WOODENWARE AND NOVELTIES.

M. L. & N. M. Howard.......................... Cairo.
L. A. Miller.................................. Cairo.
George W. Dibble.............................. Elka Park.
Edgar Palmer ................................. Freehold.
Catskill Mountain Souvenir Co................. Hensonville.
C. E. Post.................................... Palenville.

### YOKES.

L. A. Miller.................................. Cairo.

## HAMILTON COUNTY.

### BOAT AND SHIP BUILDING.

William M. Wilson.............................. Deerland.

### PLANING MILL PRODUCTS.

M. B. Horsley.............................. Alvord.
William M. Wilson.............................. Deerland.
S. M. Brownell.............................. Hope Falls.
Asa Bird.............................. Lake Pleasant.
E. A. Lamor.............................. Long Lake.
W. C. Robinson & Bro.............................. Long Lake.
Thomas W. Rogers.............................. Long Lake.
A. W. Shaw.............................. Long Lake.
Harrison-Turner Co.............................. Wells.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

M. B. Hasley.............................. Alvord.
Russell L. Merwin.............................. Towahloondah.

## HERKIMER COUNTY.

### BOAT AND SHIP BUILDING.

Parsons Bros.............................. Old Forge.

### BOOT AND SHOE FINDINGS.

Kingsley Bros.............................. Salisbury Center.

### BOXES AND CRATES, PACKING.

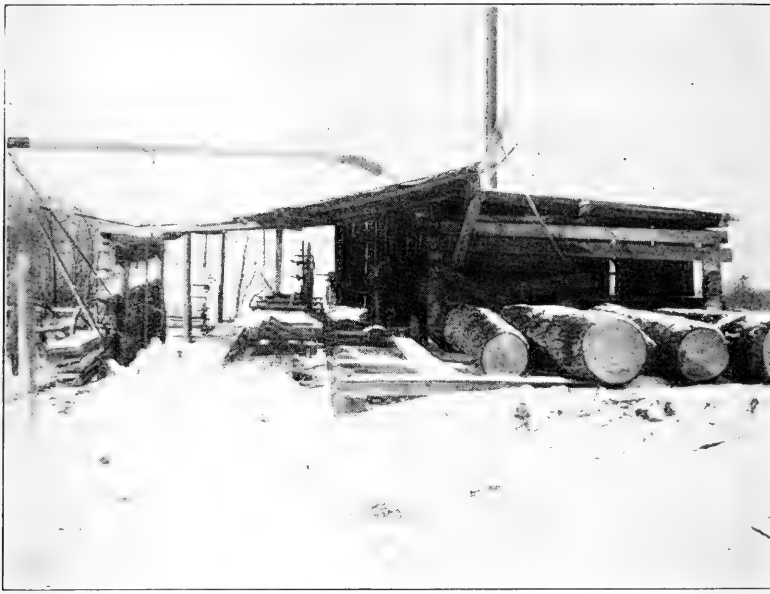
Julius Breckwaldt & Co.............................. Dolgeville.
Fred B. Chapin.............................. Dolgeville.
Acme Road Machinery Co.............................. Frankfort.
F. E. Hale Mfg. Co.............................. Herkimer.
Horrocks Desk Co.............................. Herkimer.
Wagner Couch Co.............................. Herkimer.
West Canada Lumber Co.............................. Herkimer.
Remington Arms and Ammunition Co.............................. Ilion.
Remington Typewriter Co.............................. Ilion.
A. N. Russell & Sons Co.............................. Ilion.
D. B. Burrell & Co.............................. Little Falls.
Jacob Dettinger & Son.............................. Little Falls.
The C. J. Lundstrom Mfg. Co.............................. Little Falls.
Stillman & Co.............................. Poland.

### CHAIRS.

Rhodes Chair Co.............................. Cold Brook.

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

John C. Davis.............................. Cold Brook.
C. H. Payne.............................. Cold Brook.
D. H. Burrell & Co.............................. Little Falls.
The Hall Mammoth Incubator Co.............................. Little Falls.
D. S. Tilyon.............................. Vanhornesville.
A. C. Hackley.............................. West Winfield.



A coming factor in the lumber industry. Owing to the constantly decreasing size of logging "units," the small portable sawmill is occupying a position of increasing importance.

Above is shown the hemlock logs on the skidway ready to be rolled on the carriage, the carriage itself, and some of the finished stock.

A mill of this type, if efficiently operated, should average ten thousand board feet per day. Photograph by HENRY H. TRYON.

## HERKIMER COUNTY — (Continued).

### DOWELS.

Kingsley Bros........ ............................ Salisbury Center.

### EXCELSIOR.

National Desk Co.......... ....................... Herkimer.
Standard Furniture Co............................ Herkimer.

### FIREARMS.

Remington Arms and Ammunition Co.............. Ilion.

### FIXTURES.

A. N. Russell & Sons Co.......................... Ilion.

### FURNITURE.

F. E. Hale Mfg. Co............................... Herkimer.
Horrocks Desk Co................................. Herkimer.
National Desk Co................................. Herkimer.
Majestic Furniture Co............................ Herkimer.
Standard Furniture Co............................ Herkimer.
Wagner Couch Co.................................. Herkimer.
C. J. Lundstrom Mfg. Co.......................... Little Falls.

### HANDLES.

Rhodes Chair Co.................................. Cold Brook.
Continental Tool Co.............................. Frankfort.
Union Fork and Hoe Co............................ Frankfort.
D. B. Crist...................................... Middleville.

### MUSICAL INSTRUMENTS.

Rhodes Chair Co.................................. Cold Brook.
Julius Breckwoldt & Co........................... Dolgeville.
Edward Kingsley ................................. Salisbury Center.

### MACHINE CONSTRUCTION.

Remington Typewriter Co.......................... Ilion.

### ELECTRICAL MACHINERY AND APPARATUS.

Acme Road Machinery Co........................... Frankfort.

### PATTERNS AND FLASKS.

Acme Road Machinery Co........................... Frankfort.
Remington Typewriter Co.......................... Ilion.

### PLANING MILL PRODUCTS.

George Deis, Son & Co............................ Fulton Chain.
C. R. Snell & Sons Co............................ Herkimer.
West Canada Lumber Co............................ Herkimer.
Conrad Klipple .................................. Ilion.
Andrew Little & Son.............................. Little Falls.
E. D. Conner..................................... Poland.
S. D. Tilyon..................................... Vanhornesville.

**HERKIMER COUNTY — (Continued).**

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

George Deis & Son Co.......... Fulton Chain.
Conrad Klipple .......... Ilion.
Remington Arms and Ammunition Co.......... Ilion.
Remington Typewriter Co.......... Ilion.
Andrew Little & Son.......... Little Falls.
Charles Gressel .......... Salisbury.
Kingsby Bros.......... Salisbury Center.
W. L. Purple.......... South Columbia.
George S. Weeks.......... West Winfield.
Manhattan Fire Proof Door Co.......... Winfield Junction.

TANKS AND SILOS.

George Raithel & Son.......... Middleville.
George S. Weeks.......... West Winfield.

VEHICLES AND VEHICLE PARTS.

Jacob Dettinger & Son.......... Little Falls.
D. B. Crist.......... Middleville.
George Raithel & Son.......... Middleville.
E. H. Stillman.......... Poland.
T. W. Ellis.......... Warren.
C. H. Rider & Son.......... West Winfield.

WOODENWARE AND NOVELTIES.

Rhodes Chair Co.......... Cold Brook.
W. H. Rhodes.......... Cold Brook.
Jacob Dettinger & Son.......... Little Falls.
D. B. Crist.......... Middleville.

## JEFFERSON COUNTY.

AGRICULTURAL IMPLEMENTS.

Charles Codman .......... Brownville.
George Diefendorf .......... Chaumont.

BASKETS AND FRUIT PACKAGES.

Spies Basket Co.......... Adams.

BOATS AND SHIPS.

Thomas Thurston .......... Alexandria Bay.
L. Leon Pio & Co.......... Cape Vincent.
G. W. Brown.......... Clayton.
Joel Couch .......... Clayton.
L. E. Fry & Co.......... Clayton.
Henry Thibauh .......... Clayton.
Charles H. Wilber.......... Clayton.
Bert Tyler .......... Henderson Harbor.

## JEFFERSON COUNTY — (Continued).

### BOATS AND SHIPS.

| | |
|---|---|
| James R. Bassett | Henderson Harbor. |
| Henry Brown | Henderson Harbor. |

### BOOT AND SHOE FINDINGS.

| | |
|---|---|
| McMahon & Hickey | Natural Bridge. |

### BOXES AND CRATES, PACKING.

| | |
|---|---|
| J. A. Scobell | Cape Vincent. |
| F. K. Hallett | Smithville. |
| Excelsior Carriage Co | Watertown. |
| Harman Machine Co | Watertown. |
| Union Carriage and Gear Co | Watertown. |

### CHAIRS.

| | |
|---|---|
| Black River Bending Co | Black River. |
| H. C. Dexter Chair Co | Black River. |
| Jefferson Chair Co | Carthage. |
| Indian River Chair Co | Philadelphia. |

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

| | |
|---|---|
| Spies Basket Co | Adams. |
| W. S. Brooks | Antwerp. |
| Charles E. Snell | Black River. |
| Sternberg Bros | Depauville. |
| A. A. French | Felts Mills. |
| Charles A. Van Wormer | Mannsville. |
| G. V. Storie | Oxbow. |

### EXCELSIOR.

| | |
|---|---|
| C. W. Denesia | Evans Mills. |

### FURNITURE.

| | |
|---|---|
| Black River Bending Co | Black River. |
| Louis E. Hudson | Ellisburg. |
| Groat Furniture Co | Philadelphia. |

### HANDLES.

| | |
|---|---|
| O. H. Braman | Carthage. |
| F. J. Carpenter | Oxbow. |

### PLANING MILL PRODUCTS.

| | |
|---|---|
| O. D. Greene | Adams. |
| Fred L. Webster | Adams. |
| George D. Bethel | Antwerp. |
| Charles Codeman | Brownville. |
| J. A. Scobell | Cape Vincent. |
| Adirondack Core and Plug Co | Carthage. |
| Dygert Bros | Clayton. |
| Dexter Woodworking and Builders' Supply Co | Dexter. |
| E. C. Smith | Henderson. |

## JEFFERSON COUNTY — (Continued).

### PLANING MILL PRODUCTS.

| | |
|---|---|
| A. L. Gillett | Lorraine. |
| J. A. Denney | Lorraine. |
| Bert Budlong | Natural Bridge. |
| Cook & Smith | Redwood. |
| George Heller & Co | Theresa. |
| Case Lumber and Roofing Co | Watertown. |
| Charles W. Sloat & Son | Watertown. |
| White & Sullivan | Watertown. |

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

| | |
|---|---|
| O. D. Greene | Adams. |
| Fred L. Webster | Adams. |
| Garlock Bros | Alexandria Bay. |
| George D. Bethel | Antwerp. |
| Charles E. Snell | Black River. |
| C. M. Starkweather | Carthage. |
| George Diefendorf | Chaumont. |
| Otis Brooks Lumber Co | Clayton. |
| Dexter Woodworking and Builders' Supply Co | Dexter. |
| Bert Budlong | Natural Bridge. |
| Groat Furniture Co | Philadelphia. |
| Cook & Smith | Redwood. |
| Case Lumber and Roofing Co | Watertown. |
| Charlebois Bros | Watertown. |
| J. A. Scobell | Cape Vincent. |

### VEHICLES.

| | |
|---|---|
| L. W. Roseboom | Limerick. |
| Bert Budlong | Natural Bridge. |
| F. J. Carpenter | Oxbow. |
| M. L. Stotler | Theresa. |
| H. H. Babcock Co | Watertown. |
| Excelsior Carriage Co | Watertown. |
| Union Carriage and Gear Co | Watertown. |

### WOODENWARE AND NOVELTIES.

| | |
|---|---|
| Black River Plug and Core Co | Black River. |
| Adirondack Core and Plug Co | Carthage. |
| W. L. Johnson | Theresa. |

## KINGS COUNTY.

### BOATS AND SHIPS.

| | |
|---|---|
| Ira S. Bushy | Brooklyn. |
| C. M. Englis | Brooklyn. |
| Fischer & Lagno | Brooklyn. |
| William J. & S. M. Gokey | Brooklyn. |
| Jakobson & Peterson | Brooklyn. |

## KINGS COUNTY — (Continued).

### BOATS AND SHIPS.

The Thomas Kells' Sons Co. . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
Thomas F. Meehan & Son. . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
Morse Dry Dock and Repair Co. . . . . . . . . . . . . . . . . . . Brooklyn.
New York Dry Dock and Repair Co. . . . . . . . . . . . . . . Brooklyn.
Robins Dry Dock and Repair Co. . . . . . . . . . . . . . . . . Brooklyn.
Schuyler & Caddell. . . . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
United States Navy Yard. . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.

### BOOT AND SHOE FINDINGS.

R. S. McNeill Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.

### CIGAR BOXES.

C. E. Rogers, Jr. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
Uptegrove Cigar Box Lumber Co. . . . . . . . . . . . . . . . . Brooklyn.

### BOXES AND CRATES, PACKING.

Louis Bossert & Son. . . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
Brooklyn Cooperage Co. . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
James H. Dykeman. . . . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
John A. Eckert. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
Eclipse Box and Lumber Co. . . . . . . . . . . . . . . . . . . . . Brooklyn.
Frederick Elflein & Sons. . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
Foster Pump Works. . . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
The J. Friedland Co. . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
Gluck Bros. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
Samuel Greenstein . . . . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
John Kroder and Henry Reubel Co. . . . . . . . . . . . . . . Brooklyn.
C. H. Medicus & Co. . . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
National Packing Box Co. . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
New York Bottle Box Co. . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
G. H. Reeves, Inc. . . . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
Second Avenue Planing Mill and Box Factory. . . . . . . Brooklyn.
South Brooklyn Box Factory. . . . . . . . . . . . . . . . . . . . . Brooklyn.
Edward C. Smith. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
Wood Packing Box Co. . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
Zimmerman & Voight. . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.

### CLOCKS.

The Ansonia Clock Co. . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.

### PICTURE FRAMES AND MOULDINGS.

American Moulding Co. . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
Brooklyn Carving Works. . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
John H. Gass' Sons. . . . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
Greenpoint Moulding Co. . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
Eagle Moulding Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
John Hughes' Son. . . . . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
Union Mill Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
Zimmerman & Voight. . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.
Empire Moulding Co. . . . . . . . . . . . . . . . . . . . . . . . . . . Brooklyn.

## KINGS COUNTY — (Continued).

### MUSICAL INSTRUMENTS.

Fred Gretsch Mfg. Co. .......... Brooklyn.
Freeborn G. Smith .......... Brooklyn.
Tallman Organ Co. .......... Brooklyn.
F. W. Young & Co. .......... Brooklyn.

### PROFESSIONAL INSTRUMENTS.

Eberhard Faber Pencil Co. .......... Brooklyn.

### PLANING MILL PRODUCTS.

Cropsley & Mitchell .......... Brooklyn.
Cross, Austin & Ireland Lumber Co. .......... Brooklyn.
Eagle Moulding Co., 230 Java St. .......... Brooklyn.
Eastern District Trim and Lumber Co. .......... Brooklyn.
Eclipse Box and Lumber Co., 425 Greenpoint Ave. .......... Brooklyn.
Benjamin G. Hitchings, East 34th and Ave. M. .......... Brooklyn.
Johnson Bros., 45 Classon Ave. .......... Brooklyn.
John S. Loomis Co. .......... Brooklyn.
A. Merkinson, 554 Hamilton Ave. .......... Brooklyn.
Mullin, Wagner & Co., 2828–30 West 16th St. .......... Coney Island.
Charles Rothenback .......... Brooklyn.
Second Avenue Planing Mill and Box Factory .......... Brooklyn.
J. Schindele's Son .......... Brooklyn.
Edward C. Smith, 420 Oakland St. .......... Brooklyn.
Hardy Vorhees & Co. .......... Brooklyn.
Samuel Weinstein Estate .......... Brooklyn.

### PLUMBERS' WOOD WORK.

M. P. Berglass Mfg. Co. .......... Brooklyn.
Coyne & Delany Co. .......... Brooklyn.
Raebeck & Zinthum .......... Brooklyn.

### REFRIGERATORS AND KITCHEN CABINETS.

Colonial Mantel and Refrigerator Co. .......... Brooklyn.
Frederick Elflein & Sons .......... Brooklyn.
Greiner Construction Co. .......... Brooklyn.
A. & M. Heckelmann .......... Brooklyn.
McKee Refrigerator Co. .......... Brooklyn.
Manhattan Cabinet Works .......... Brooklyn.

### SHADE AND MAP ROLLERS.

John Kroder & Henry Reubel Co. .......... Brooklyn.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Rilate & Parker .......... Brooklyn.
The Roebuch Weather Strip and Wire Screen Co. .......... Brooklyn.
Rubin Graw Co. .......... Brooklyn.
J. Schindele's Sons .......... Brooklyn.
Stanley & Unckles, Inc. .......... Brooklyn.
Samuel Weinstein Est. .......... Brooklyn.

## KINGS COUNTY — (Continued).

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

| | |
|---|---|
| George Alexander Co. / Brooklyn Fireproof Sash and Door Co. | Brooklyn. |
| Cohen & Gran | Brooklyn. |
| Colonial Mantle and Refrigerator Co. | Brooklyn. |
| Columbia Mantle Co. | Brooklyn. |
| John C. Creveling | Brooklyn. |
| Cross, Austin & Ireland Lumber Co. | Brooklyn. |
| Eastern District Furniture and Lumber Co. | Brooklyn. |
| Eastern Woodworking Co. | Brooklyn. |
| Eastern Mantel Co. | Brooklyn. |
| East New York Wrecking Lumber Co. | Brooklyn. |
| Empire City Girard Co. | Brooklyn. |
| A. Entenman, Inc. | Brooklyn. |
| I. Feldman | Brooklyn. |
| Fisher & Voorhees | Brooklyn. |
| Flemish Art Co. | Brooklyn. |
| C. B. French Cabinet Co. | Brooklyn. |
| D. P. Gardner & Son | Brooklyn. |
| Greenport Sash and Door Co. | Brooklyn. |
| Benjamin G. Hitchings | Brooklyn. |
| Frank Hockin | Brooklyn. |
| Interborough Sash and Door Co. | Brooklyn. |
| S. Jacobs & Sons | Brooklyn. |
| Kwilandzik & Alpert, Inc. | Brooklyn. |
| Levin Kronenberg & Co. | Brooklyn. |
| John S. Loomis Co. | Brooklyn. |
| C. R. McCaulay Co. | Brooklyn. |
| Michael Mayer | Brooklyn. |
| Frank A. Maron Co., Inc. | Brooklyn. |
| Meisel-Danowitz Co. | Brooklyn. |
| Meisel Muschel & Co. | Brooklyn. |
| Jacob Morganthaw & Sons | Brooklyn. |
| A. Morkinson | Brooklyn. |
| Albro J. Newton Co. | Brooklyn. |
| Osborn Sash and Door Co. | Brooklyn. |
| C. H. Pearson | Brooklyn. |
| Prospect Parquet Floor Co. | Brooklyn. |
| Prims & Klein | Brooklyn. |
| V. E. Reich | Brooklyn. |
| Reliance Fireproof Door Co. | Brooklyn. |

### TANKS AND SILOS.

| | |
|---|---|
| Becker Tank Mfg. Co. | Brooklyn. |
| Mayer Tank Mfg. Co. | Brooklyn. |
| National Cooperage Co. | Brooklyn. |

### VEHICLES AND VEHICLE PARTS.

| | |
|---|---|
| Thomas Rockford | Brooklyn. |
| Shadbolt Mfg. Co. | Brooklyn. |
| J. A. Shephard & Son | Brooklyn. |

**KINGS COUNTY** — (Continued).

WOODENWARE AND NOVELTIES.

J. K. Brown Co., 181 Third Ave.................. Brooklyn.
Wright L. Glidden.............................. Brooklyn.

## LEWIS COUNTY.

BOATS AND SHIPS.

Thaler Bros.................................... Lyons Falls.

BOXES AND CRATES, PACKING.

Climax Mfg. Co................................. Castorland.
J. S. Twinning Estate.......................... Copenhagen.
Asbestos Burial Casket Co...................... Lowville.

CASKETS AND COFFINS.

New York and Brooklyn Casket Co................ Brooklyn.
Morgan Casket Co............................... Brooklyn.
Asbestos Burial Casket Co...................... Lowville.

DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

A. J. Ward..................................... Copenhagen.
James H. Steiner............................... Croghan.
Henry Rimiller & Son........................... West Leyden.

DOWELS.

Glenfield Mfg. Co.............................. Glenfield.

EXCELSIOR.

Fenton & Dence................................. Lowville.
Jesse H. Wilder................................ Petries Corner.
Port Leyden Excelsior Co....................... Port Leyden.

FURNITURE.

J. E. Haberer Furniture Co..................... Lowville.

HANDLES.

Parker & Barnes................................ Parkers.

LAUNDRY APPLIANCES.

Thaler Bros.................................... Lyons Falls.

PLANING MILL PRODUCTS.

C. B. Rebb..................................... Barnes Corner.
The Steam Mill Co.............................. Constableville.
John B. Austin................................. Copenhagen.
James Carey.................................... Copenhagen.
J. F. Farney................................... Croghan.
J. R. Lafavre Lumber Co........................ Croghan.
E. S. Virkler.................................. Croghan.
Glenfield Mfg. Co.............................. Glenfield.

**LEWIS COUNTY** — (Continued).

PLANING MILL PRODUCTS.

W. Johnson .................................... Glenfield.
Reuben A. Kilbourn, Esq .................................... Harrisville.
John Moore .................................... Harrisville.
Glen M. Parker .................................... Lowville.
John Tisse .................................... New Bremen.
Fred Weist .................................... Talcottville.
Hugh Hughes .................................... Turin.

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

E. S. Virkler .................................... Croghan.
W. Johnson .................................... Glenfield.
Frank Hoskins .................................... Lyons Falls.
John Tisse .................................... New Bremen.
George W. Post .................................... Port Leyden.
Hugh Hughes .................................... Turin.

SHUTTLES, SPOOLS AND BOBBINS.

Glenfield Mfg. Co .................................... Glenfield.

SPORTING AND ATHLETIC GOODS.

Thaler Bros .................................... Lyons Falls.

VEHICLES AND VEHICLE PARTS.

The Steam Mill Co .................................... Constableville.

WOODENWARE AND NOVELTIES.

Glenfield Mfg. Co .................................... Glenfield.

## LIVINGSTON COUNTY.

AGRICULTURAL IMPLEMENTS.

Champion Drill Co .................................... Avon.
Bean Harvester Co .................................... Caledonia.
Wells Purcell .................................... Hemlock.
Genesee Valley Mfg. Co .................................... Mt. Morris.

BOXES AND CRATES, PACKING.

George F. Scott .................................... Dansville.
Wiard Mfg. Co .................................... East Avon.
Foote Mfg. Co .................................... Nunda.

CASKETS.

Nunda Casket Co .................................... Nunda.

CHAIRS.

The George Arndt Chair Co .................................... Dansville.

FURNITURE.

Louis Cary .................................... Hemlock.

**LIVINGSTON COUNTY — (Continued).**

LAUNDRY APPLIANCES.

Wiard Mfg. Co. .................................... East Avon.

MACHINE CONSTRUCTION.

Foote Mfg. Co. .................................... Nunda.

PLANING MILL PRODUCTS.

Fountain & Miller .................................... Dansville.
W. F. Smith .................................... Dansville.
Ellwood Barringer .................................... Springwater.
Frank H. Stuart .................................... Springwater.

PUMPS.

H. E. Hubbard Co .................................... Dansville.

VEHICLES.

W. E. Cole .................................... Avon.
R. C. Waldo .................................... Avon.

## MADISON COUNTY.

AGRICULTURAL IMPLEMENTS.

Babcock Mfg. Co. .................................... Leonardsville.
Munnsville Plow Co .................................... Munnsville.
T. C. Ginney .................................... Peterboro.
C. C. Kirkland .................................... Pratts Hollow.

BASKETS AND FRUIT PACKAGES.

W. N. Cardner .................................... New Woodstock.
Lyons Mills .................................... Solsville.

BOATS AND SHIPS.

William H. Lindley Co .................................... Canastota.

BOXES AND CRATES, PACKING.

Canastota Couch Co .................................... Canastota.
Ellis, Joyce & Hildreth .................................... Canastota.
Cornell Table Co .................................... Earlville.
Hamilton Lumber Co .................................... Hamilton.
Lee Chair Co .................................... Oneida.
Oneida Steel Pulley Co .................................... Oneida.
Schubert Bros. Gear Co .................................... Oneida.

CASKETS AND COFFINS.

National Casket Co .................................... Oneida.

CHAIRS.

Canastota Couch Co .................................... Canastota.
Lee Chair Co .................................... Oneida.

## MADISON COUNTY — (Continued).

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

W. N. Cardner.................................. North Woodstock.

### FURNITURE.

Canastota Couch Co.................................. Canastota.
Ellis, Joyce & Hildreth.................................. Canastota.
Steuben Library and Furniture Co.................................. Canisteo.
A. D. Morton.................................. Eaton.
Bentley Bros.................................. Earlville.
Cornell Table Co.................................. Earlville.
Ferrara Furniture Co.................................. Oneida.
Morse Lumber Co.................................. Sheds.

### MACHINE CONSTRUCTION.

William Dobson .................................. Canastota.

### PLANING MILL PRODUCTS.

N. V. Reynolds.................................. Georgetown.
F. M. Purdy.................................. Morrisonville.
M. H. Forbes.................................. North Brookfield.
Morse Lumber Co.................................. Sheds.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

T. W. Thayer Co.................................. Cazenovia.
Hamilton Lumber Co.................................. Hamilton.
F. M. Purdy.................................. Morrisonville.
W. L. Field.................................. Morrisville.
M. Davenport .................................. Peterboro.

### TANKS AND SILOS.

D. W. Palmer.................................. Hubbardsville.
Lyons Mills .................................. Solsville.

### VEHICLES AND VEHICLE PARTS.

Watson Wagon Co.................................. Canastota.
The Parsons Wagon Co.................................. Earlville.
William L. Field.................................. Morrisville.
F. J. Aubeuf.................................. Oneida.
Theodore Barrett & Sons.................................. Oneida.
August Schubert Wagon Co.................................. Oneida.
Schubert Bros. Gear Co.................................. Oneida.
Siver Carriage Co.................................. Oneida.
T. C. Ginney.................................. Peterboro.
C. C. Kirkland.................................. Pratts Hollow.
Lyons Mills .................................. Solsville.

### WOODENWARE, NOVELTIES, ETC.

C. C. Kirkland.................................. Pratts Hollow.
Lyons Mills .................................. Solsville.

### MISCELLANEOUS. Kiln Slats.

Munnsville Plow Co.................................. Munnsville.

## MONROE COUNTY.

### AGRICULTURAL IMPLEMENTS.

| | |
|---|---|
| P. J. Burdett | Clifton. |
| Ontario Drill Co. | East Rochester. |
| Geo. P. Bortle Co | Rochester. |

### BASKETS AND FRUIT PACKAGES.

| | |
|---|---|
| Irondequoit Coal and Supply Co | Irondequoit. |
| J. D. Nivison | Webster. |
| Webster Basket Co | Webster. |

### BOATS AND SHIPS.

| | |
|---|---|
| Bull Bros. | Rochester. |
| Wm. V. Long | Rochester. |

### BOXES AND CRATES, PACKING.

| | |
|---|---|
| Cobb Preserving Co | Fairport. |
| Ontario Drill Co | East Rochester. |
| James S. Lord | Penfield. |
| American Laundry and Machinery Mfg. Co | Rochester. |
| American Piano Co | Rochester. |
| American Wood Working Machinery Co | Rochester. |
| Archer Mfg. Co | Rochester. |
| Barnard & Simonds Co | Rochester. |
| Brooks Furniture Mfg. Co | Rochester. |
| Cooperative Foundry Co | Rochester. |
| General Railway Signal Co | Rochester. |
| John A. Hartfelder | Rochester. |
| John C. Hughes | Rochester. |
| Langslow Fowler Co | Rochester. |
| Henry Likly & Co. | Rochester. |
| Geo. J. Nichelsen Furniture Co | Rochester. |
| Chas. K. Newberry | Rochester. |
| Rochester Show Case Works | Rochester. |
| Stromkey Carlson Tel. Mfg. Co | Rochester. |
| Sullivan Bros. | Rochester. |
| Traders' Box and Lumber Co. | Rochester. |
| Wood Working Machinery Co | Rochester. |
| Yawman & Erbe Mfg. Co | Rochester. |

### BRUSHES AND BROOMS.

| | |
|---|---|
| Geo. P. Bortle | Rochester. |
| Merchants' Transportation and Dispatch Co | East Rochester. |

### CAR CONSTRUCTION.

| | |
|---|---|
| Rochester, Buffalo & Pittsburgh Ry | Rochester. |

### CASKETS AND COFFINS.

| | |
|---|---|
| National Casket Co | Rochester. |
| Monroe Mfg. Co | Webster. |
| O'Dell Bros. | Webster. |

## MONROE COUNTY — (Continued).

### CHAIRS.

| | |
|---|---|
| S. Cooper | Clifton. |
| Archer Mfg. Co | Rochester. |
| Barnard & Simonds Co | Rochester. |
| Hubbard, Elbridge & Miller | Rochester. |
| Langelow, Fowler & Co. | Rochester. |
| Chas. K. Newberry | Rochester. |

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

| | |
|---|---|
| Rochester Box and Lumber Co | Rochester. |
| Star Egg Carrier and Tray Mfg. Co | Rochester. |

### DOWELS.

| | |
|---|---|
| Geo. P. Butte Co | Rochester. |

### FIXTURES.

| | |
|---|---|
| S. W. Storandt Mfg. Co | Rochester. |
| Archer Mfg. Co | Rochester. |
| John Hoffman Co | Rochester. |
| J. H. Reinhard & Son | Rochester. |
| Rochester Cabinet Co | Rochester. |
| Rochester Show Case Works | Rochester. |

### GATES.

| | |
|---|---|
| J. H. Reinhard & Son | Rochester. |
| Rochester Cabinet Co | Rochester. |
| Rochester Show Case Works | Rochester. |
| J. W. Storandt Mfg | Rochester. |

### FRAMES AND MOULDINGS.

| | |
|---|---|
| J. W. Gillis Co | Rochester. |
| John C. Heughes | Rochester. |
| N. L. Lockhart Co | Rochester. |
| Rochester Moulding Works | Rochester. |
| John Searvogel | Rochester. |
| Buffalo, Rochester and Pittsburgh Ry. Co | Rochester. |

### FURNITURE.

| | |
|---|---|
| Albin Geyer | Rochester. |
| Blum & Michelson | Rochester. |
| Bohm Cabinet Co | Rochester. |
| Brooks Furniture Mfg. Co | Rochester. |
| The Hayden Co | Rochester. |
| Hopeman Bros. Lumber and Mfg. Co | Rochester. |
| Geo. J. Michelson Furniture Co | Rochester. |
| Miller Cabinet Co | Rochester. |
| Perrin Co. | Rochester. |
| J. H. Reinhard & Sons | Rochester. |
| Vetter Desk Works | Rochester. |
| Yawman & Erbe Mfg. Co | Rochester. |

## MONROE COUNTY — (Continued).

### GATES AND FENCING.

Buffalo, Rochester and Pittsburgh Ry. Co.......... Rochester.

### MUSICAL INSTRUMENTS.

Brockport Piano Mfg. Co........................ Brockport.
B. F. Gleason Mfg. Co.......................... Brockport.
American Piano Co.............................. Rochester.
Gibbons & Stone................................ Rochester.
The Phelps & Lyddon Co......................... Rochester.
M. S. Phelps Mfg. Co........................... Rochester.
Ropelt & Sons Piano Co......................... Rochester.

### PROFESSIONAL INSTRUMENTS.

James S. Lord.................................. Penfield.
American Drafting Furniture Co................. Rochester.
Wm. G. Bell.................................... Rochester.
Geo. P. Bortle Co.............................. Rochester.
Eastman Kodak Co............................... Rochester.

### LAUNDRY APPLIANCES.

American Laundry Machine Co.................... Rochester.
Geo. P. Bortle Co.............................. Rochester.

### MACHINE CONSTRUCTION.

American Wood Working Machine Co............... Rochester.
Hopeman Bros. Lumber and Mfg. Co............... Rochester.

### MACHINERY AND APPARATUS, ELECTRICAL.

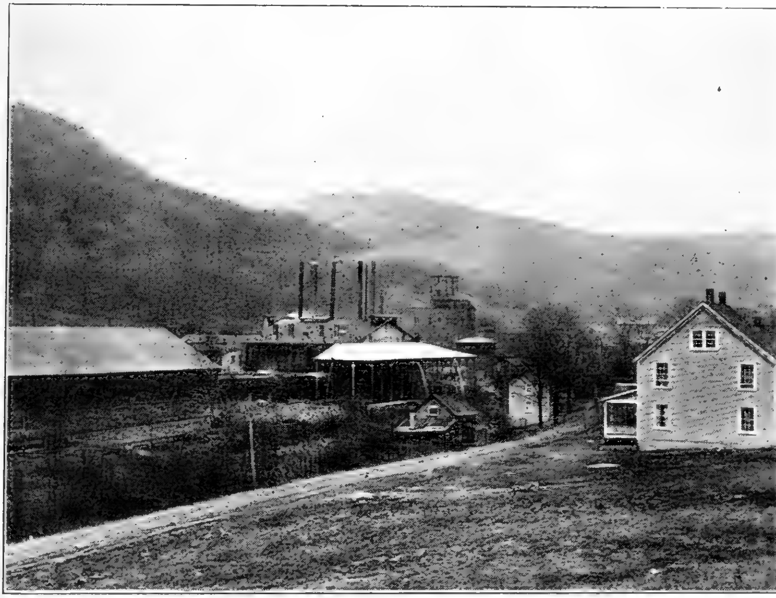
James S. Lord.................................. Penfield.
General Railway Signal Co...................... Rochester.
Stromberg Carlson Tel. Mfg. Co................. Rochester.

### PATTERNS AND FLASKS.

American Laundry Machinery Co.................. Lincoln Park and Rochester.
American Wood Working Machinery Co............. Rochester.
Cooperative Foundry Co......................... Rochester.

### PLANING MILL PRODUCTS.

A. Matthews.................................... Charlotte.
L. H. Lusk..................................... Pittsford.
Wadhams & Whitlock............................. Pittsford.
Banteleon Bros. Co............................. Rochester.
Wm. G. Bell.................................... Rochester.
P. Enders...................................... Rochester.
Chas. P. Evans Co.............................. Rochester.
The Hayden Co.................................. Rochester.
Wm. B. Morse Lumber Co......................... Rochester.
J. H. Reinhard & Sons.......................... Rochester.
Rochester Box and Lumber Co.................... Rochester.



General view of Keery Chemical Co.'s wood distillation plant near Cadosia, N. Y. On the left is the charcoal house; next are the two sets of cooling ovens, and in the center is the oven house with the smoke-stacks. This plant has a refinery. It is shown on the immediate right of the oven house. Photograph by NELSON C. BROWN.

## MONROE COUNTY — (Continued).

### PLANING MILL PRODUCTS.

Rochester Trim Co........ Rochester.
C. H. Rugg Co........ Rochester.
Spencer Lumber Co........ Rochester.
Stoertz Bros........ Rochester.
Traders Box and Lumber Co........ Rochester.
Williamson Mill and Lumber Co........ Rochester.

### REFRIGERATORS AND KITCHEN CABINETS.

C. W. Trotter Sons........ Rochester.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Fairport Lumber and Coal Co........ Fairport.
Banteleon Bros. Co........ Rochester.
Chapman & Goetzman........ Rochester.
Crouch & Beahan Co........ Rochester.
P. Enders........ Rochester.
Hopeman Bros. Lumber and Manufacturing Co........ Rochester.
Rochester Cabinet Co........ Rochester.
Rochester Trim Co........ Rochester.
C. H. Rugg Co........ Rochester.
Smith Sash and Door Co........ Rochester.
Spencer Lumber Co........ Rochester.
Geo. H. Stalker........ Rochester.
Traders' Box and Lumber Co........ Rochester.
Vogel & Binder........ Rochester.
Wood-Mosaic Co........ Rochester.
Williamson Mill and Lumber Co........ Rochester.
O'Dell Bros........ Webster.

### SPORTING AND ATHLETIC GOODS.

Frank Schwikert & Son........ Rochester.

### TANKS AND SILOS.

Hopeman Bros. Lumber and Mfg. Co........ Rochester.
Spencer Lumber Co........ Rochester.
Yawman & Erbe Co........ Rochester.

### TRUNKS AND BAGS.

Henry Likly & Co........ Rochester.

### VEHICLES.

Caley & Nash........ Brighton.
Rochester Wheel Co........ Brockport.
G. G. Bown & Son........ Fairport.
C. A. Lind & Son........ Morton.
L. H. Lusk........ Pittsford.
American Laundry Machinery Co........ Rochester.
Jas. Cunningham & Sons Co........ Rochester.
Deusing & Zieres........ Rochester.

**MONROE COUNTY** — (Continued).

VEHICLES.

Hoffman Wagon and Carriage Co.................. Rochester.
Geo. A. Lane.................................... Rochester.
Fred C. Rehtz.................................. Rochester.
W. H. Rowerdink & Son........................... Rochester.
A. F. and S. C. Stewart......................... Rochester.
Sullivan Bros. ................................. Rochester.
Ellsworth Carver ............................... Scottsville.

WOODENWARE AND NOVELTIES.

P. J. Burdett ................................... Clifton.
F. B. Pease Co.................................. Rochester.

MISCELLANEOUS.

Embalming Boards.

B. F. Gleason Mfg. Co........................... Brockport.

Drying Slats.

O'Dell Bros. ................................... Webster.

## MONTGOMERY COUNTY.

AGRICULTURAL IMPLEMENTS.

Clark Machine Co................................ St. Johnsville.

BOXES AND CRATES, PACKING.

Henry C. Grieme Co.............................. Amsterdam.
Bailey Knitting Mills........................... Fort Plain.
Century Cabinet Co.............................. Fort Plain.
Empire Cooping Co............................... Fultonville.
White Mop Wringer Co............................ Fultonville.

DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

Empire Cooping Co............................... Fultonville.

FURNITURE.

Century Cabinet Co.............................. Fort Plain.
A. and C. A. Hix................................ Fort Plain.

MUSICAL INSTRUMENTS.

Fort Plain Electric Piano Co.................... Fort Plain.
Frederick Englehardt & Sons..................... St. Johnsville.

PROFESSIONAL INSTRUMENTS.

White Mop Wringer Co............................ Fultonville.

MACHINE CONSTRUCTION.

Alphonso Walrath Co............................. Fort Plain.

## MONTGOMERY COUNTY — (Continued).

### PLANING MILL PRODUCTS.

J. D. Lasher.......... Amsterdam.
Wm. Servoss & Son.......... Amsterdam.
Fort Plain Mfg. Co.......... Fort Plain.
Clinton C. Fusmer.......... Palatine Bridge.
Charles H. Burkdorf.......... St. Johnsville.
A. Sponable.......... St. Johnsville.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Brookside Lumber Co.......... Amsterdam.
Francis Gilliland's Sons.......... Amsterdam.
Henry C. Grieme.......... Amsterdam.
Kelly-Brayton Co.......... Amsterdam.
McNeil Mfg. Co.......... Amsterdam.
John H. Kneeskern & Sons.......... St. Johnsville.

### VEHICLES AND VEHICLE PARTS.

Saltsman Wagon Co.......... St. Johnsville.

### WOODENWARE AND NOVELTIES.

White Mop Wringer Co.......... Fultonville.

## NASSAU COUNTY.

### AEROPLANES.

American Aeroplane Supply House.......... Hempstead.

### BOAT AND SHIP BUILDING.

Walter Southard.......... East Rockway.
Bedell & Son.......... Glenwood Landing.
Fyfe & Hittorff.......... Glenwood Landing.
Frank Southard.......... Seaford.

### BOXES AND CRATES, PACKING.

Bausch Picture Frame and Moulding Co.......... Farmingdale.
Doubleday, Page & Co.......... Garden City.
American Aeroplane Supply House.......... Hempstead.

### PICTURE FRAMES AND MOULDINGS.

Bausch Picture Frame and Moulding Co.......... Farmingdale.

### FURNITURE.

James R. Richardson & Son.......... Lawrence.

### GATES AND FENCING.

Conklin, Tubby & Conklin.......... Roslyn.
Ansel Raynor.......... Seaford.

## NASSAU COUNTY — (Continued).

### MUSICAL INSTRUMENTS.

Reuben Midmer & Son.............................. Merrick.

### PLANING MILL PRODUCTS.

George Kaiser .................................. Inwood.
J. H. Smith..................................... Lawrence.
South Side Mill................................. Rockville Center.
Conklin, Tubby & Conklin........................ Roslyn.
Isaac Hicks .................................... Roslyn.

### PLUMBERS' WOODWORK.

Ansel Raynor ................................... Seaford.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

F. D. Smith .................................... Baldwin.
Charles Davison................................. East Rockaway.
H. L. Post...................................... Farmingdale.
Wood Mfg. and Realty Co......................... Great Neck.
Wm. Plyer & Co.................................. Hempstead.
B. Thomas....................................... Hempstead.
Chas. H. Voight Estate.......................... Hicksville.
George Kaiser .................................. Inwood.
Isaac Hicks..................................... Roslyn.
Conklin, Tubby & Conklin........................ Roslyn.

### SIGNS AND SUPPLIES.

Mellen & Waboda................................. Mineola.

### VEHICLES AND VEHICLE PARTS.

B. Brown (successor to Q. W. Valentine)............ Hempstead.
W. J. Fox....................................... Glen Head.
Schenck Bros. .................................. Great Neck.
Mellen & Waboda................................. Mineola.
Conklin, Tubby & Conklin........................ Roslyn.
N. Forges ...................................... Roslyn.

## NEW YORK COUNTY.

### AEROPLANES.

Beekman Sash, Door and Woodworking Co.......... New York.

### BOAT AND SHIP BUILDING.

Gas Engine and Power Co. and Charles Seabury & Co. (consolidated) ........................ Morris Heights.
Tregarther & Sons' Co........................... New York.
Wood & McClure.................................. New York.
William D. Dale................................. New York.
John P. Hawkins................................. New York.
Robert Jacobs .................................. New York.
McAllister Dry Dock and Ship Yard Co............ New York.

NEW YORK COUNTY — (Continued).

Frank McWilliams .......... New York.
W. F. Ruddock Yacht Works .......... New York.
Shewan & Sons .......... New York.
Spearin & Preston .......... New York.
Henry Steers Inc .......... New York.
James Tregarthen .......... New York.

BOXES AND CRATES, PACKING.

Gas Engine and Power Co. and Charles Seabury & Co. (consolidated) .......... Morris Heights.
Knickerbocker Box and Lumber Co .......... New York.
Charles Kern .......... New York.
S. Liebovitz & Sons .......... New York.
Thomas J. Locke & Son .......... New York.
Peter J. Lowell .......... New York.
L. H. Mace & Co. Inc .......... New York.
Manhattan Box Co .......... New York.
Marks Adjustable Chair Co .......... New York.
Alfred B. Marx & Bro .......... New York.
McConnell Mfg. Co .......... New York.
John Mills & Son .......... New York.
Terrance Montague .......... New York.
John E. Moore .......... New York.
John Neeley & Son .......... New York.
G. G. Newcomb Mfg. Co .......... New York.
Palmer & Embury Mfg. Co .......... New York.
T. G. Patterson Lumber Co .......... New York.
Potter & Stymus Co .......... New York.
Paul Pratho, Jr. .......... New York.
J. Rathman .......... New York.
Reddis Lumber and Veneer Co .......... New York.
Riddick & Co .......... New York.
Rosenthal & Cohen .......... New York.
L. H. Russell (box manufacturers) .......... New York.
P. Ryan .......... New York.
Theodore Sauer Co .......... New York.
Schwab Bros. Co .......... New York.
Star Box Co .......... New York.
United Box Co .......... New York.
F. Vogel & Co .......... New York.
James G. Wilson Mfg. Co .......... New York.
F. R. Abbey .......... New York.
Advance Box Co .......... New York.
American Hard Rubber Co .......... New York.
American Piano Co .......... New York.
E. J. Armstrong .......... New York.
Artists' Packing and Shipping Co .......... New York.
L. Baldasky .......... New York.
Frederick Base .......... New York.
Fred Bieg .......... New York.

## NEW YORK COUNTY — (Continued).

### BOXES AND CRATES, PACKING.

Charles F. Biele & Sons' Co........................ New York.
Bohn Syphon Refrigerator Co........................ New York.
I. N. Burdick........................ New York.
Jabez Burns & Sons........................ New York.
Carroll Box and Lumber Co........................ New York.
Library Bureau ........................ New York.
Ronalds & Johnson Co........................ New York.
Doernberg & Goodman........................ New York.
John Dunbar Co. Inc. ........................ New York.
Dunbar Box and Lumber Co........................ New York.
Epstein & Vollweiler........................ New York.
James Fagan & Son........................ New York.
Feldman Packing Box Co........................ New York.
J. H. Fitzgerald........................ New York.
Forest Box and Lumber Co........................ New York.
E. Gerow ........................ New York.
J. A. Gilmour........................ New York.
M. Gottlieb & Sons........................ New York.
Greenfield Box Co........................ New York.
Thomas Harrington & Co........................ New York.
John Helmsky ........................ New York.
H. Henmann Furniture Co........................ New York.
Hill & Newmann Co........................ New York.
H. F. Huber & Co........................ New York.
George Hunzinger & Son........................ New York.
Kaffenberger & Cantor Co........................ New York.
George Kidney ........................ New York.

### CAR CONSTRUCTION.

New York Central and Hudson River Railroad...... New York.
J. P. Sjoberg Co........................ New York.

### CASKETS AND COFFINS.

Kiechman & Co........................ New York.
Hornthal & Co........................ New York.
J. and J. W. Holts........................ New York.
H. E. Taylor & Co........................ New York.

### CHAIRS.

Jacob Dieter & Sons' Co........................ New York.
George Huzinger & Son........................ New York.
Metropolitan Chair Co........................ New York.
John Mills & Son........................ New York.
New York Chair Co........................ New York.
George T. Sargent Co........................ New York.
G. Wagman ........................ New York.

### CIGAR BOXES.

Nicholas Althaus Co........................ New York.
Bubeck & Guerin........................ New York.

## NEW YORK COUNTY — (Continued).

### CIGAR BOXES.

S. Elkeles Cigar Box Co.............................. New York.
Grausam & Sachs.............................. New York.
James P. Prendergast.............................. New York.
Schwarzkopf & Ruckert.............................. New York.
S. Sladkers.............................. New York.
Charles Stultz Co.............................. New York.
J. C. Van Brunt & Sons.............................. New York.
Louis Walter.............................. New York.

### ELEVATORS.

M. Cullen.............................. New York.
Anton Larsen & Co.............................. New York.
Bardsley Bros.............................. New York.
Perry & Son.............................. New York.
William Williams Co.............................. New York.

### FIXTURES.

Bardsley Bros. Co.............................. New York.
Amman Mfg. and Construction Co.............................. New York.
Becker & Korb.............................. New York.
The Brunswick-Balke-Collender Co.............................. New York.
Demarest & Eckerson.............................. New York.
Drossin Bros.............................. New York.
Joseph Feldman.............................. New York.
Gustave Frank.............................. New York.
The J. Friedland Co.............................. New York.
Jacob Froehlich Cabinet Works.............................. New York.
Martin T. Garvey.............................. New York.
Glassburg & Cantner.............................. New York.
William Kleeman & Co.............................. New York.
Klingle Mfg. Co.............................. New York.
David Kramer.............................. New York.
J. and R. Lamb.............................. New York.
Samuel Lakow.............................. New York.
Manhattan Office Partition Co.............................. New York.
Manhattan Show Case Co.............................. New York.
National Show Case Co.............................. New York.
New York Store Fixture Co.............................. New York.
Perry & Son.............................. New York.
Charles E. Reynolds.............................. New York.
Ely J. Riesser & Co.............................. New York.
Arthur J. Reisser & Co.............................. New York.
C. Reiger's Sons Inc.............................. New York.
Glasser, Rohrer & Co.............................. New York.
Roth & Co.............................. New York.
Seger & Gross Co.............................. New York.
Robert Wick Lumber Co.............................. New York.

## NEW YORK COUNTY — (Continued).

### PICTURE FRAMES AND MOULDINGS.

| | |
|---|---|
| D. Milch | New York. |
| J. Bosowsky | New York. |
| J. N. Budick | New York. |
| William Klein | New York. |
| Klingle Mfg. Co | New York. |
| National Moulding Co | New York. |
| F. J. Newcomb Mfg. Co | New York. |
| New York Carved Moulding Co | New York. |
| S. and R. Frame Mfg. Co | New York. |
| Tremont Moulding Mill | New York. |
| Ullman Mfg. Co | New York. |
| Western Frame Co | New York. |
| G. Wuerth Mfg. Co | New York. |
| Zubinsky Bros. | New York. |

### FURNITURE.

| | |
|---|---|
| Rimone Mfg. Co | New York. |
| John A. Banks & Bros | New York. |
| August Casiraghi | New York. |
| H. J. & J. Cohen | New York. |
| Diechman & Co | New York. |
| Jacob Dieter & Sons' Co | New York. |
| Henry Fuldner & Sons | New York. |
| Glassberg & Cantner | New York. |
| Max Greenspan | New York. |
| John Helmsky | New York. |
| H. Herrmann Furniture Co | New York. |
| Hofstatter's Sons Inc | New York. |
| Laum & Sons | New York. |
| Library Bureau | New York. |
| Nicholas Liesenheim | New York. |
| B. Lion Furniture Co | New York. |
| L. Marcotte & Co | New York. |
| John Mills & Son | New York. |
| William F. Meltz | New York. |
| Palmer & Embury Mfg. Co | New York. |
| T. G. Patterson Lumber Co | New York. |
| Perry & Son | New York. |
| Potter & Stymus Co | New York. |
| Henry Raabe & Sons | New York. |
| M. Reischmann & Son Inc, | New York. |
| Richter Furniture Co | New York. |
| Reddis Lumber and Veneer Co | New York. |
| Roebuck Weather Strip and Wire Screen Co | New York. |
| L. H. Russell | New York. |
| Theodór Saner Co | New York. |
| F. Schaettler | New York. |
| Schilling Bros. Table Co | New York. |
| E. Schloss & Co | New York. |
| Philip Strobel & Sons | New York. |

## NEW YORK COUNTY — (Continued).

### FURNITURE.

G. Wagman ........ New York.
F. Vogel & Co........ New York.
John Walsh ........ New York.
Ludwig Zodikow ........ New York.

### HANDLES.

New York Mallet and Handle Works........ New York.

### MACHINE CONSTRUCTION.

De La Vergne Machine Co........ New York.

### ELECTRICAL MACHINERY AND APPARATUS.

Bubeck & Guerin........ New York.
Electric Fireproofing Co........ Tompkins Sq. Station.
F. J. Newcomb Mfg. Co........ New York.

### MUSICAL INSTRUMENTS.

American Piano Co........ New York.
Autotone Company ........ New York.
Behning Piano Co........ New York.
C. E. Bryne Piano Co........ New York.
Biddle Piano Co........ New York.
Christman Piano Co........ New York.
Joseph N. Courtade........ New York.
Jacob Doll & Sons........ New York.
Duchman & Co........ New York.
Dusinberre & Co........ New York.
Eastey Piano Co........ New York.
Hardman, Peck & Co........ New York.
Hazelton Bros........ New York.
Kaffenberger & Cantor........ New York.
Kindler & Collins........ New York.
Kohler & Campbell........ New York.
Kranich & Bach........ New York.
Kroeger Piano Co........ New York.
The Laffargue Co........ New York.
Lockhart & Co........ New York.
Ludwig & Co........ New York.
Paul G. Mehlin & Sons........ New York.
J. H. & C. S. Odell & Co........ New York.
Ricca & Son, Inc. ........ New York.
George Schliecher ........ New York.
The Schubert Piano Co........ New York.
The Staib Abendschein Co........ New York.
Standard Pneumatic Action Co........ New York.
Steinway & Sons........ New York.
Sohmer & Co........ New York.
Strauch Bros. ........ New York.
Stultz & Bauer........ New York.

## NEW YORK COUNTY — (Continued).

### MUSICAL INSTRUMENTS.

Votey Organ Co. . . . . . . . . . New York.
Wasle & Company . . . . . . . . . . New York.
Walters Piano Co. . . . . . . . . . New York.
Weber Piano Co. . . . . . . . . . New York.
Weser Bros. . . . . . . . . . New York.
Wessell, Nichol & Groos . . . . . . . . . . New York.

### PROFESSIONAL INSTRUMENTS.

Eagle Pencil Co. . . . . . . . . . New York.
F. & O. Cedar Works, Ltd. . . . . . . . . . New York.

### PATTERNS AND FLASKS.

George Fox & Sons . . . . . . . . . . New York.
De LaVergne Machine Co. . . . . . . . . . New York.

### PLANING MILL PRODUCTS.

Ahnehan Co. . . . . . . . . . New York.
Bardsley Bros. . . . . . . . . . New York.
Beekman Sash, Door and Woodworking Co. . . . . . . . . . New York.
Alexander R. Brown . . . . . . . . . . New York.
John A. Delatone . . . . . . . . . . New York.
Dunbar Box and Lumber Co. . . . . . . . . . New York.
East River Mill and Lumber Co. . . . . . . . . . New York.
East Side Planing Mill . . . . . . . . . . New York.
F. Eckenroth . . . . . . . . . . New York.
Jacob Froelich Cabinet Works . . . . . . . . . . New York.
Hanson-Turner Co. . . . . . . . . . New York.
Hasbrouck Flooring Co. . . . . . . . . . New York.
Haynes & Coryell . . . . . . . . . . New York.
Kalt Lumber Co. . . . . . . . . . New York.
James McBride Co. . . . . . . . . . New York.
McConnell Mfg. Co. . . . . . . . . . New York.
J. F. McLaughlin . . . . . . . . . . New York.
Manhattan Woodworking Co. . . . . . . . . . New York.
F. R. Merrall & Co. . . . . . . . . . New York.
Mershon & Morley Co. . . . . . . . . . New York.
Mount & Robertson . . . . . . . . . . New York.
J. F. Murphy Lumber Co. . . . . . . . . . New York.
Murray & Hill Co., Inc. . . . . . . . . . New York.
T. G. Patterson Lumber Co. . . . . . . . . . New York.
Perry & Son . . . . . . . . . . New York.
C. Rieger's Sons, Inc. . . . . . . . . . New York.
Schuyler Flooring Co. . . . . . . . . . New York.
Sloane & Moller . . . . . . . . . . New York.
Smith & Lenhart . . . . . . . . . . New York.
Tuttle Bros. . . . . . . . . . . New York.
T. D. Wadelton . . . . . . . . . . New York.
West 30th Street Planing Mill . . . . . . . . . . New York.
William P. Youngs & Bros. . . . . . . . . . New York.
Zubrinsky Mldg. Mfg. Co. . . . . . . . . . New York.

## NEW YORK COUNTY — (Continued).

### PLUMBERS' WOODWORK.

William S. Emery.................................. New York.

### PRINTING MATERIAL.

Printers' Supply Co.............................. New York.

### REFRIGERATORS AND KITCHEN CABINETS.

Bohn Syphon Refrigerator Co........................ New York.
Buzzini & Co...................................... New York.
Dubois Mfg. Co.................................... New York.
Anton Larson & Son................................ New York.
James McLean ..................................... New York.
L. H. Mace & Co., Inc............................. New York.
William Williams & Co............................. New York.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

F. Schaettler .................................... New York.
P. Scollon ....................................... New York.
Shollenberger & Co................................ New York.
Star Fire-Proof Door and Sash Co., Inc............ New York.
C. S. Utterson.................................... New York.
Tiger & Dreeben................................... New York.
The Unionport Lumber and Mfg. Co.................. New York.
United Metal-Covered Door and Sash Co............. New York.
United Parquet Flooring Co........................ New York.
United States Metal Products Co................... New York.
Valiquet & Neelson................................ New York.
Herman Vossnack .................................. New York.
A. Weinstock ..................................... New York.
Westchester Woodworking Co........................ New York.
Alfred Wick ...................................... New York.
James G. Wilson Mfg. Co........................... New York.
Wilson Woodworking Co............................. New York.
F. E. Zimmerman................................... New York.
Abramson & Engesser Co............................ New York.
American Mantel Mfg. Co........................... New York.
American Wood Carpet Flooring Co.................. New York.
William Anderson ................................. New York.
Atlantic Coast Lumber Corporation................. New York.
Bayer Cotton Co................................... New York.
Beekman Sash, Door and Woodworking Co............. New York.
Charles F. Biele & Sons Co........................ New York.
William D. Bird................................... New York.
John H. Boynton................................... New York.
Bronx Sash and Door Co............................ New York.
John H. Carl...................................... New York.
Century Cabinet Co................................ New York.
A. C. Chesley Co.................................. New York.
Chautauqua Planing Mill Co........................ New York.
Claremont Lumber and Mfg. Co...................... New York.

## NEW YORK COUNTY — (Continued).

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Colonial Column Mfg. Co........................ New York.
John Cronk & Sons........................ New York.
William L. Dale........................ New York.
Electric Fireproofing Co........................ New York.
Empire City Gerard Co........................ New York.
Empire Door and Trim Co........................ New York.
Eureka Woodworking Co........................ New York.
Thomas Farrell ........................ New York.
G. Fenante ........................ New York.
Fischer Bros. ........................ New York.
James C. Forbes........................ New York.
Glaser, Rohrer & Co........................ New York.
Globe Fireproof Door and Sash Co........................ New York.
Greater New York Sash and Door Co........................ New York.
Harlem River Lumber and Woodworking Co........................ New York.
Hogan & Di Genno........................ New York.
Howell, Field & Goddard, Inc. ........................ New York.
H. F. Huber & Co........................ New York.
Hudson Mantel and Mirror Co........................ New York.
Hudson Woodworking Co........................ New York.
Jamestown Mantel Co........................ New York.
L. Kantor & Co........................ New York.
The W. Keck & Co........................ New York.
L. Kern ........................ New York.
Kessler Bros........................ New York.
Charles H. Keys........................ New York.
A. Kimball & Sons........................ New York.
G. W. Koch & Son........................ New York.
Kalt Lumber Co........................ New York.
Charles Krohn ........................ New York.
J. & R. Lamb........................ New York.
The Lorillard Refrigerator Co........................ New York.
P. McCarthy ........................ New York.
McConnell Mfg. Co........................ New York.
Mandel-Williams Lumber Co........................ New York.
Manhattan Fireproof Door Co........................ New York.
J. Marcus Woodworking Co........................ New York.
Louis Marx & Son........................ New York.
H. H. Meise........................ New York.
F. R. Merrell & Son........................ New York.
Mount & Robertson........................ New York.
Tuttle Bros. ........................ New York.
Niagara Woodworking Co........................ New York.
M. F. O'Neill, Inc........................ New York.
Oriental Fireproof Sash and Door Co........................ New York.
T. G. Patterson Lumber Co........................ New York.
Pioneer Woodwork Co........................ New York.
Perry & Son........................ New York.
Charles A. Pope........................ New York.
Potter & Stymus Co........................ New York.

**NEW YORK COUNTY — (Continued).**

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Charles Read.............................. New York.
Charles E. Reynolds.......................... New York.
Arthur J. Rieser & Co.......................... New York.
Roebuck Weather Strip and Wire Screen Co........ New York.
J. & W. Robb.............................. New York.
H. B. Rummler.............................. New York.
The Sandhop Contracting Co.................... New York.
J. M. Saulpaugh's Son......................... New York.

SHADE AND MAP ROLLERS.

Columbia Western Mills....................... New York.

SIGNS AND SUPPLIES.

Charles Krohn .............................. New York.

SPORTING AND ATHLETIC GOODS.

Bell, Sandford & Lahm......................... New York.
The Brunswick-Balke-Collender Co............... New York.
Bubeck & Guerin............................. New York.
Alfred B. Marx & Bro.......................... New York.
Rilper Mfg. Co.............................. New York.
H. Wagner & Adler Co......................... New York.

TANKS AND SILOS.

Thomas Farrell ............................. New York.
David Isaacs ............................... New York.
Launer Bros. ............................... New York.
Shwab Bros. Co.............................. New York.

TRUNKS AND VALISES.

Manhattan Trunk Co.......................... New York.
Charap & Mark.............................. New York.
F. R. Merrall & Co........................... New York.
New York Trunk Box Factory................... New York.
C. A. Taylor Trunk Works...................... New York.

WHIPS, CANES AND UMBRELLA STICKS.

Arthur W. Ware & Co......................... New York.

VEHICLES AND VEHICLE PARTS.

George Anthon .............................. New York.
Burr & Co.................................. New York.
A. T. Demarest & Co.......................... New York.
William Doherty & Son........................ New York.
Richard G. Green............................ New York.
George Irving Co............................ New York.
William Keil ............................... New York.
C. P. Ketterer.............................. New York.
C. L. Knoeller.............................. New York.
William Koenig ............................. New York.

## NEW YORK COUNTY — (Continued).

### VEHICLES AND VEHICLE PARTS.

J. Kramer & Sons' Mfg. Co........................ New York.
The Liberty Wagon Works........................ New York.
Lippard-Stewart Motor Truck Co................. New York.
Marquard Truck Co.............................. New York.
Jacob Mattern Wagon Co......................... New York.
F. R. Messell & Co............................. New York.
D. P. Nichols & Co............................. New York.
Perry & Son.................................... New York.
Peters & Heins................................. New York.
H. Reinmulder & Sons........................... New York.
Estate of Charles Scheideler................... New York.
Sebastian Wagon Co............................. New York.
Senderling Mfg. Co............................. New York.
J. A. Shepard & Son............................ New York.
J. P. Sjoberg.................................. New York.
John Thenser................................... New York.
A. Unger....................................... New York.
Herman G. Wittowsky............................ New York.

### WOODENWARE AND NOVELTIES.

Chesebro-Whitman Co., 1167 First Ave........... New York.
Grausam & Sachs, 1269 Broadway................. New York.
New York Ladder Co., 580 Hudson St............. New York.
George T. Sargent Co., 289 Fourth Ave.......... New York.
Ullman Mfg. Co................................. New York.

### MISCELLANEOUS.

#### Matches.

Diamond Match Co............................... New York.

#### Butcher's Blocks.

Thomas Farrell................................. New York.

#### Sewing Machines.

Singer Mfg. Co................................. New York.

#### Fillers for Rails.

G. F. Smith.................................... New York.

## NIAGARA COUNTY.

### AGRICULTURAL IMPLEMENTS.

Friend Mfg. Co................................. Gasport.

### BASKETS AND FRUIT PACKAGES.

Bacon & Co..................................... Gasport.
Willis Halsted................................. Middleport.
Ransomville Basket Co.......................... Ransomville.
Frank L. Mead.................................. Somerset.

## NIAGARA COUNTY — (Continued).

### BOAT AND SHIP BUILDING.

| | |
|---|---|
| Lockport Dry Docks | Lockport. |
| Niagara Motor Boat Co | No. Tonawanda. |
| Thompson, Hubman & Fisher | No. Tonawanda. |

### BOXES AND CRATES, PACKING.

| | |
|---|---|
| Evans & Co | Lockport. |
| Frontier Box and Mfg. Co | Lockport. |
| Lockport Box and Lumber Co | Lockport. |
| Merritt Mfg. Co | Lockport. |
| W. W. Taylor | Lockport. |
| John C. Webb | Lockport. |
| F. I. Alliger | No. Tonawanda. |
| W. H. Crabb | No. Tonawanda. |
| Dock and Mill Co | No. Tonawanda. |
| North Tonawanda Musical Instrument Works | No. Tonawanda. |
| White, Gratwick & Mitchell | No. Tonawanda. |
| Rudolph Wurlitzer Mfg. Co | No. Tonawanda. |
| Wood Fibre Box Co | Sanborn. |

### PLAYGROUND EQUIPMENT.

| | |
|---|---|
| Evans & Co | Lockport. |
| Herschel-Spillman Co | No. Tonawanda. |

### FIXTURES.

| | |
|---|---|
| Wicker Lumber Co | Niagara Falls. |

### FURNITURE.

| | |
|---|---|
| S. P. McCoy | Lockport. |
| Dock and Mill Co | No. Tonawanda. |
| Hutchins-Kilbourn Co | No. Tonawanda. |

### INSTRUMENTS, MUSICAL.

| | |
|---|---|
| Niagara Musical Instrument Co | No. Tonawanda. |
| North Tonawanda Musical Instrument Works | No. Tonawanda. |
| Rudolph Wurlitzer Mfg. Co | No. Tonawanda. |

### MACHINE CONSTRUCTION.

| | |
|---|---|
| W. D. Davis | Lockport. |
| Merritt Mfg. Co | Lockport. |
| Joseph Whalen | Lockport. |

### MACHINERY AND APPARATUS, ELECTRICAL.

| | |
|---|---|
| Hall Iron Works | Lockport. |

### PATTERNS AND FLASKS.

| | |
|---|---|
| Gardner Foundry Co | Lockport. |
| Hall Iron Works | Lockport. |
| Lockport City Pattern Works | Lockport. |
| McKim Foundry and Machine Co | Lockport. |
| Merritt Mfg. Co | Lockport. |

## NIAGARA COUNTY — (Continued).

### PLANING MILL PRODUCTS.

| | |
|---|---|
| L. C. Lum | Barker. |
| Webster C. Woodworth | Gasport. |
| Newfane Basket Mfg. Co | Newfane. |
| Ayers & Witmer Lumber Co | Niagara Falls. |
| Haeberle Lumber Co | Niagara Falls. |
| Wicker Lumber Co | Niagara Falls. |
| Ray H. Bennett | No. Tonawanda. |
| George Berry & Co | No. Tonawanda. |
| The Charles G. Doebler Planing Mill | No. Tonawanda. |
| W. G. Palmer | No. Tonawanda. |
| Robinson Bros. Lumber Co | No. Tonawanda. |
| Thompson, Hubman & Fisher | No. Tonawanda. |
| White, Gratwick & Mitchell | No. Tonawanda. |
| L. W. Wiedman | No. Tonawanda. |
| A. J. Servis & Son | Youngstown. |

### PULLEYS AND CONVEYORS.

| | |
|---|---|
| Western Block Co | Lockport. |

### PUMPS.

| | |
|---|---|
| American District Steam Co | No. Tonawanda. |

### REFRIGERATORS AND KITCHEN CABINETS.

| | |
|---|---|
| Wicker Lumber Co | Niagara Falls. |

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

| | |
|---|---|
| Webster C. Woodworth | Gasport. |
| W. G. Damerow | Lockport. |
| Lock City Pattern Works | Lockport. |
| S. P. McCloy | Lockport. |
| Joseph W. Turner | Lockport. |
| Joseph Whalen | Lockport. |
| Newfane Basket and Mfg. Co | Lockport. |
| Ayers & Witmer | Niagara Falls. |
| Haeberle Lumber Co | Niagara Falls. |
| August Steinbrenner | Niagara Falls. |
| Wicker Lumber Co | Niagara Falls. |
| Dock and Mill Co | No. Tonawanda. |
| The Charles G. Doebler Planing Mill | No. Tonawanda. |
| W. G. Palmer | No. Tonawanda. |
| Thompson, Hubman & Fisher | No. Tonawanda. |

### TANKS AND SILOS.

| | |
|---|---|
| Nicholas Bower | Gasport. |
| Newfane Basket and Mfg. Co | Newfane. |
| Thompson, Hubman & Fisher | No. Tonawanda. |
| Van Slyke & Co | No. Tonawanda. |

### TOYS.

| | |
|---|---|
| Buffalo Sled Co | No. Tonawanda. |

Wood yard of the Maryland Wood Products Co. at Maryland, Otsego county, showing the character of limb and body wood, chiefly beech, birch and maple. This wood is seasoned from one to two years before being run into the ovens and made into charcoal, wood alcohol and acetate of lime.
Photograph by NELSON C. BROWN.

**NIAGARA COUNTY** — (Continued).

VEHICLES AND VEHICLE PARTS.

Webster C. Woodworth........................... Gasport.
Willis Halstead .................................. Middleport.
Newfane Basket Mfg. Co........................ Newfane.
Buffalo Sled Co.................................... No. Tonawanda.

WOODENWARE AND NOVELTIES.

Bacon & Co.......................................... Appleton and Gasport.
Webster C. Woodworth........................... Gasport.
Willis Halstead .................................. Middleport.
Newfane Basket and Mfg. Co.................. Newfane.
Buffalo Sled Co.................................... No. Tonawanda.
Hutchins-Kilbourn Co........................... No. Tonawanda.

## ONEIDA COUNTY.

BASKETS AND FRUIT PACKAGES.

Estate of Charles R. Hayes..................... Forestport.

BOAT AND SHIP BUILDING.

Estate of Michael Doran........................ Durhamville.
William J. Ridgely............................... Boonville.
David Swancott.................................... Lee Center.

BOXES AND CRATES, PACKING.

Clayville Knitting Co........................... Clayville.
F. H. Conant Sons................................ Camden.
C. T. Meeker....................................... Camden.
Louis Perrin........................................ Camden.
W. W. Russel....................................... Camden.
John M. Young & Son........................... Camden.
Frank S. Hardin Co.............................. McConnellsville.
Hatheway & Reynolds........................... Oriskany Falls.
H. Waterbury & Sons' Co...................... Oriskany Falls.
Beach Lumber Co................................. Rome.
D. J. Blasier........................................ Rome.
Rome Box and Lumber Co..................... Rome.
N. A. Tyler Lumber Co......................... Vernon.
A. G. Houser....................................... West Branch.

CHAIRS.

Peter Fry............................................. Ava.
F. H. Conant's Sons.............................. Camden.
John M. Young & Son........................... Camden.
W. E. Sprague...................................... Westdale.

## ONEIDA COUNTY — (Continued).

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

| | |
|---|---|
| Charles Oper | Ava. |
| David Kailer | Boonville. |
| James Keating | East Florence. |
| Z. L. Tompkins | Florence. |
| Charles R. Hayes | Forestport. |
| R. G. Jones | Glenmore. |
| G. B. Gerard | Holland Patent. |
| Allyn E. Greene | Lee Center. |
| G. H. Whittaker | Marcy. |
| Charles E. Gue | North Western. |
| Gordon W. Stetson | Stockwell. |

### EXCELSIOR.

| | |
|---|---|
| Brant Excelsior Co | Hawkinsville. |
| Charles Harden | McConnellsville. |

### FIREARMS.

| | |
|---|---|
| Savage Arms Co | Utica. |

### FURNITURE.

| | |
|---|---|
| W. F. Babcock | Camden. |
| F. W. Becker | Camden. |
| F. S. Harden Co | Camden. |
| Louis Perrin | Camden. |
| Frank S. Harden Co | McConnellsville. |
| The N. A. Tyler Lumber Co | Vernon. |
| The Quigley Furniture Co | Whitesboro. |

### HANDLES.

| | |
|---|---|
| David Swancott | Lee Center. |
| D. J. Blazier | Rome. |
| John F. Clark | Florence. |

### MACHINE CONSTRUCTION.

| | |
|---|---|
| C. E. Morey | Utica. |

### PLANING MILL PRODUCTS.

| | |
|---|---|
| H. R. Loveland | Boonville. |
| W. F. Babcock | Camden. |
| T. E. Davis | Clayville. |
| J. H. Waterman | Deansboro. |
| George W. Dana | Camden. |
| W. L. Hart | Franklin Springs. |
| David Swancott | Lee Center. |
| Beach Lumber Co | Rome. |
| J. E. Davis & Son | Sauquoit. |
| Gordon W. Stockton | Stockwell. |
| Amos Nellis & Swift | Utica. |
| Charles C. Kellogg & Sons' Co | Utica. |
| Kimball Lumber Co | Utica. |
| Philip Thomas & Sons | Utica. |
| The N. A. Tyler Lumber Co | Vernon. |
| A. G. Houser | West Branch. |
| Denton & Waterbury | Whitesboro. |

## ONEIDA COUNTY — (Continued).

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

| | |
|---|---|
| A. E. Norton | Augusta. |
| H. R. Loveland | Boonville. |
| George W. Dana | Camden. |
| Robert C. Brockway | Clinton. |
| Francis L. Fountain | Forestport. |
| Charles E. Gue | North Western. |
| Beach Lumber Co | Rome. |
| E. Comstock | Rome. |
| Charles C. Kellogg & Son Co | Utica. |
| Amos Nellis & Swift | Utica. |
| Philip Thomas & Sons | Utica. |
| N. A. Tyler Lumber Co | Vernon. |
| E. A. Wheeler | Waterville. |
| Denton & Waterbury | Whitesboro. |

### SPORTING AND ATHLETIC GOODS.

| | |
|---|---|
| John F. Clark | Florence. |

### TANKS AND SILOS.

| | |
|---|---|
| H. R. Loveland | Boonville. |
| Robert C. Brockway | Clinton. |
| T. J. Parry | Remsen. |
| J. E. Davis & Son | Sauquoit. |

### TRUNKS AND VALISES.

| | |
|---|---|
| H. C. Faber & Son Co | Utica. |
| N. A. Tyler Lumber Co | Vernon. |

### VEHICLES.

| | |
|---|---|
| A. E. Norton | Augusta. |
| C. J. Meeker | Camden. |
| Robert C. Brockway | Clinton. |
| Swarthout Mfg. Co | Clinton. |
| T. J. Parry | Remsen. |
| J. W. Reed | Remsen. |
| Fitch Gear Co | Rome. |
| J. E. Davis & Sons | Sauquoit. |
| Bailey & Brown | Utica. |
| Phil Hammes & Sons | Utica. |
| Walling's Carriage Works | Utica. |
| Willoughby & Co | Utica. |
| E. A. Wheeler | Waterville. |

## ONONDAGA COUNTY.

### AGRICULTURAL IMPLEMENTS.

| | |
|---|---|
| C. J. Peters | Fabius. |
| Norman B. Sheppard | Skaneateles. |
| J. I. Case Threshing Machine Co | Syracuse. |
| Engelberg, Huller Co | Syracuse. |
| E. C. Stearns Co | Syracuse. |
| Syracuse Chilled Plow Co | Syracuse. |

## ONONDAGA COUNTY — (Continued).

### BASKETS AND FRUIT PACKAGES.

L. Bellaire & Son.... Ebenezer.
Jacob Bittel .... Liverpool.
John Bittel .... Liverpool.
A. H. Crawford.... Liverpool.
Miller Bros.... Liverpool.
Joseph Schaefer & Co.... Liverpool.
Beneke Traisler .... Liverpool.

### BOAT AND SHIP BUILDING.

T. M. Milton.... Brewerton.
E. M. Klock & Sons, Inc.... Syracuse.

### BOXES, CIGAR.

Martin Hengstler .... Syracuse.

### BOXES AND CRATES, PACKING.

C. J. Peters.... Fabius.
S. Cheney & Sons.... Manlius.
E. U. Scoville Co.... Manlius.
O. M. Edwards Co.... Syracuse.
Boomer & Boschort Press Co.... Syracuse.
C. G. Brown Furniture Co.... Syracuse.
J. I. Case Threshing Machinery Co.... Syracuse.
The Engleburg Huller Co.... Syracuse.
Gould Storage Battery Co.... Syracuse.
John H. Lyons.... Syracuse.
Markert Mfg. Co.... Syracuse.
P. B. & H. Moulding Co.... Syracuse.
The Piquet Box and Lumber Co.... Syracuse.
Quaint Art Furniture Co.... Syracuse.
E. C. Stearns Co.... Syracuse.
Gustav Stickley Co.... Syracuse.
Syracuse Chilled Plow.... Syracuse.
Syracuse Glass Co.... Syracuse.

### CASKETS, BURIAL.

John Marcellas Mfg. Co.... Syracuse.

### CHAIRS.

Elbridge Chair Co.... Elbridge.
The Elgin A. Simonds Co.... Syracuse.
Uhle & Kramer Box Co.... Syracuse.

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

D. S. Mawson.... Manlius.
Hart & Beebe.... Rose Hill.

### DOWELS.

C. J. Peters.... Fabius.
Gould Storage Battery Co.... Syracuse.

### EXCELSIOR.

Cottle Bros. .... Hart Lot.

## ONONDAGA COUNTY — (Continued).

### FIREARMS.

Lefevre Arms Co.............................. Syracuse.

### FIXTURES.

Doxtader & Wilcoxen.............................. Syracuse.

### FRAMES AND MOULDINGS.

James Cantwell .............................. Amber.
P. B. & H. Moulding Co.............................. Syracuse.

### FURNITURE.

Mottville Chair Works, Inc. .............................. Mottville.
Butler Mfg. Co.............................. Syracuse.
C. G. Brown Furniture Co.............................. Syracuse.
John W. Juhl.............................. Syracuse.
Quaint Art Furniture Co.............................. Syracuse.
Gustave Stickley Co.............................. Syracuse.
Doxtader & Wilcoxen.............................. Syracuse.
The Cy Brown Furniture Co.............................. Syracuse.

### HANDLES.

Dodge & Zuill.............................. Syracuse.
E. C. Stearns Co.............................. Syracuse.

### INSTRUMENTS, MUSICAL.

The Amphion Co.............................. Syracuse.
Thomas Knollin .............................. Syracuse.

### LAUNDRY APPLIANCES.

A. H. Crawford.............................. Liverpool.

### MACHINE CONSTRUCTION.

S. Cheney & Sons.............................. Manlius.
Boomer & Boschert Press Co.............................. Manlius.
The Engelberg Huller Co.............................. Manlius.
Moore Trench Machine Co.............................. Manlius.
Straight Line Engine Works.............................. Manlius.
J. I. Case Threshing Machine Co.............................. Manlius.
Dodge & Zuill.............................. Manlius.

### MACHINERY AND APPARATUS, ELECTRICAL.

Gould Storage Battery Co.............................. Syracuse.

### PATTERNS AND FLASKS.

S. Cheney & Son.............................. Manlius.
E. U. Scoville Co.............................. Manlius.
The Engelberg Huller Co.............................. Syracuse.
Straight Line Engine Works.............................. Syracuse.
Gould Storage Battery Co.............................. Syracuse.
E. C. Stearns Co.............................. Syracuse.
Fraser & Jones Foundry Co.............................. Syracuse.
Smith & Caffrey Co.............................. Syracuse.
Van Wie Pump Co.............................. Syracuse.

## ONONDAGA COUNTY — (Continued).

### PLANING MILL PRODUCTS.

Builders' Mfg. Co.............................. Syracuse.
E. E. Chapman & Sons, Inc...................... Syracuse.
E. M. Klock & Sons, Inc........................ Syracuse.
The Piquet Box and Lumber Co................... Syracuse.
John J. Sherlock............................... Syracuse.
Butler Mfg. Co................................. Syracuse.

### REFRIGERATORS AND KITCHEN CABINETS.

Hart & Beebe................................... Rose Hill.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

C. J. Peters................................... Fabius.
Norman B. Shepard.............................. Syracuse.
Hueber Bros.................................... Syracuse.
Frazier & Wilcox............................... Syracuse.
E. M. Klock & Sons, Inc........................ Syracuse.
John H. Lyons.................................. Syracuse.
Markert Mfg. Co................................ Syracuse.
Doxtader & Wilcoxen............................ Syracuse.
William Sherlock............................... Syracuse.
John J. Sherlock............................... Syracuse.
E. C. Stearns Co............................... Syracuse.
Syracuse Woodcrafters.......................... Syracuse.
Adam Theobald.................................. Syracuse.
Tuck Woodworking and Building Co............... Syracuse.
Syracuse Corner Block Factory.................. Syracuse.

### SPORTING AND ATHLETIC GOODS.

J. D. Babcock.................................. Syracuse.
C. L. Castle................................... Syracuse.

### TOYS.

E. U. Scoville Co.............................. Manlius.

### VEHICLES.

Willis Kinyon.................................. Amber.
F. E. Hobert................................... Apulia.
Jordan Wheelbarrow Co.......................... Jordan.
W. Marshall.................................... Plainville.
W. C. Woodford................................. Pompey.
Chase Motor Truck Co........................... Syracuse.
H. H. Franklin Mfg. Co......................... Syracuse.
Central City Wheel Works....................... Syracuse.
E. M. Klock & Sons, Inc........................ Syracuse.
Charles Schlosser's Sons....................... Syracuse.
Syracuse Chilled Plow Co....................... Syracuse.
H. A. Moyer Auto Co............................ Syracuse.

### WOODENWARE, NOVELTIES, ETC.

John Marcellas Mfg. Co......................... Syracuse.

## ONTARIO COUNTY.

### AGRICULTURAL IMPLEMENTS.

| | |
|---|---|
| Neenan Bros. | East Bloomfield. |
| Crown Mfg. Co | Phelps. |
| Papec Machine Co | Shortsville. |
| Star Seeder Co | Shortsville. |

### BASKETS AND FRUIT PACKAGES.

| | |
|---|---|
| P. J. Burdett | Clifton. |

### BOXES AND CRATES, PACKING.

| | |
|---|---|
| Lisk Mfg. Co | Canandaigua. |
| Judd & Leland Mfg. Co | Clifton Springs. |
| Geneva Wagon Co | Geneva. |
| Crown Mfg. Co | Phelps. |
| Papec Machine Co | Shortsville. |

### BOAT AND SHIP BUILDING.

| | |
|---|---|
| William Garratt | Canandaigua. |
| Fay & Brown Engraving Co | Geneva. |

### FURNITURE.

| | |
|---|---|
| W. E. Brewer | Geneva. |
| J. B. Smith & Co | Geneva. |

### PLANING MILL PRODUCTS.

| | |
|---|---|
| Frank R. Beecher | Canandaigua. |
| George T. Thompson | Canandaigua. |
| K. Brownell | Fishers. |
| Harry Morrison | Forestine. |
| R. J. Rogers Lumber Co | Geneva. |
| F. A. Jones | Holcomb. |
| Manning & Reddant | Naples. |

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

| | |
|---|---|
| J. G. Henry | Geneva. |
| Williams Lumber Co | Geneva. |
| F. A. Jones | Holcomb. |

### VEHICLES.

| | |
|---|---|
| Neenan Bros. | Bloomfield. |
| Wm. Garratt | Canandaigua. |
| George T. Thompson | Canandaigua. |
| Frank Cram | Geneva. |
| Geneva Wagon Co | Geneva. |
| Shortsville Wheel Co | Shortsville. |

## ORANGE COUNTY.

### AGRICULTURAL IMPLEMENTS.

Coldwell Lawn Mower Co........................ Newburgh.

### BASKETS AND FRUIT PACKAGES.

Florida Package Mfg. Co........................ Florida.

### BOAT AND SHIP BUILDING.

T. S. Marvel Shipbuilding Co..................... Newburgh.

### BOXES AND CRATES, PACKING.

Rider Ericsson Engine Co........................ Walden.

### BRUSHES AND BROOMS.

New York, Ontario and Western Railroad Co........ Middletown.
J. C. White.................................... Newburgh.

### CAR CONSTRUCTION.

Lehigh & Hudson River Railway Co................ Warwick.

### GATES AND FENCING.

Beardslee Lumber Co........................... Port Jervis.

### HANDLES.

The Jennings & Griffin Mfg. Co.................. Port Jervis.

### PATTERNS AND FLASKS.

New York, Ohio and Western Railroad Co.......... Middletown.

### PLANING MILL PRODUCTS.

H. R. Taylor.................................. Cornwall.
Yagel Bros. .................................. Highland Falls.
Beardslee Lumber Co........................... Port Jervis.
V. B. Horton.................................. Warwick.
Welch Bros. .................................. Warwick.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Mead & Craft Co............................... Cornwall Landing.
Harriman Industrial Corporation................. Harriman.
Newburgh Planing Mill Co........................ Newburgh.
Daniel S. Tuthill.............................. Newburgh.
J. C. White.................................... Newburgh.
W. W. Hendrickson Co........................... Port Jervis.

### VEHICLES.

George H. Brooks.............................. Chester.
S. Wilkin & Sons.............................. Chester.
Miller Cart Co................................ Goshen.
Arthur Colvill ............................... Newburgh.
C. J. Hilliker................................ Newburgh.
Otto Nott .................................... Newburgh.
The Whitten Mfg. Co........................... Pine Bush.

**ORANGE COUNTY** — (Continued).

WOODENWARE AND NOVELTIES.

E. B. Talbot.................................. Cornwall-on-Hudson.
Chasse Mfg. Co................................ Middletown.
D. W. Sayer................................... Unionville.

## ORLEANS COUNTY.

BASKETS AND FRUIT PACKAGES.

C. M. Mallory................................. Albion.
Seymour Terwilliger........................... Medina.

BOXES AND CRATES, PACKING.

Frank Ellicott ............................... Eagle Harbor.
Carr, Eggleston & Riz......................... Kendall.
S. A. Cook & Co............................... Medina.
J. W. Jackson & Co............................ Medina.
Maher Bros. Co................................ Medina.
Monitor Clock Works........................... Medina.

CHAIRS.

S. A. Cook & Co............................... Medina.
Maher Bros. Co................................ Medina.

CLOCKS.

Monitor Clock Works........................... Medina.

FURNITURE.

J. W. Jackson & Co............................ Medina.
J. A. Cook & Co............................... Medina.
Empire Couch Co............................... Medina.
Maher Bros. Co................................ Medina.
Monitor Clock Works........................... Medina.

LAUNDRY APPLIANCES.

Frank Ellicott ............................... Eagle Harbor.

PLANING MILL PRODUCTS.

C. M. Mallory................................. Albion.
Frank Ellicott ............................... Eagle Harbor.
Holland Planing Mill Co....................... Holland.
U. L. Ceole................................... Holley.
John Murphy .................................. Holley.
J. C. Gray & Co............................... Lyndonville.

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

C. M. Mallory................................. Albion.
J. C. Gray & Co............................... Lyndonville.
J. W. Jackson Co.............................. Medina.

TANKS AND SILOS.

C. M. Mallory................................. Albion.

# OSWEGO COUNTY.

## AGRICULTURAL IMPLEMENTS.

George J. Emery Co.......................... Fulton.
The Johnston Harvester Co.......................... Redfield.

## BOXES AND CRATES, PACKING.

Charles M. Allen, Inc.......................... Fulton.
Dilts Machine Works.......................... Fulton.
Majestic Furniture Co.......................... Mexico.
National Starch Co.......................... Oswego.
Standard Oil Co.......................... Oswego.
Salmon River Table Co.......................... Pulaski.

## CHAIRS.

Horton Lumber Co.......................... Altmar.
Majestic Furniture Co.......................... Mexico.
W. H. Lattimer & Sons.......................... Orwell.
Sinclair Chair Co.......................... Phoenix.
F. B. Woodbury.......................... Phoenix.

## DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

D. E. Mason.......................... Fulton.
George A. Courbat.......................... Mallory.
Fred Babcock.......................... Orwell.

## PLAYGROUND EQUIPMENT.

W. H. Lattimer & Son.......................... Orwell.

## EXCELSIOR.

Charles M. Allen, Inc.......................... Fulton.

## FURNITURE.

Kraus Mfg. Co.......................... Constantia.
Majestic Furniture Co.......................... Mexico.
Romaine Bros. .......................... Oswego.
A. Paine & Son.......................... Oswego.
Post & Henderson Co.......................... Oswego.
J. E. Jones.......................... Oswego.
Salmon River Table Co.......................... Pulaski.
Curtis Spring Bed Co.......................... Richland.

## HANDLES.

Parish Fibre and Broom Co.......................... Parish.
Edgar W. Comino.......................... Redfield.
Elmer A. Durst.......................... Redfield.

## MUSICAL INSTRUMENTS.

Robert G. Potter.......................... Orwell.

## MACHINE CONSTRUCTION.

Dilts Machine Works.......................... Fulton.
Oil Wells Supply Co.......................... Oswego.

## OSWEGO COUNTY — (Continued).

### PATTERNS AND FLASKS.

Dilts Machine Works.......... Fulton.

### PLANING MILL PRODUCTS.

Stanley J. House.......... Colosse.
D. W. Smith.......... Central Square.
W. A. Barlow.......... Lacona.
The Blount Lumber Co.......... Lacona.
George A. Courbat.......... Mallory.
Mrs. J. K. Ames.......... Mexico.
J. J. Vault.......... Mexico.
Frank E. Miller.......... Parish.
W. M. Wilder.......... Pulaski.

### SHADE AND MAP ROLLERS.

Minetto-Meridan Co.......... Minetto.
Parish Fibre and Broom Co.......... Parish.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

D. W. Smith.......... Central Square.
George A. Courbat.......... Mallory.
J. J. Vault.......... Mexico.
James C. Harding & Son.......... Oswego.
Oswego Novelty Works.......... Oswego.
Post & Henderson.......... Oswego.
S. E. Fournier.......... Oswego.
C. J. Wiley.......... Oswego.
Charles Tollner's Sons Co.......... Pulaski.
W. H. Wilder.......... Pulaski.

### TANKS AND SILOS.

Post & Henderson.......... Oswego.
Sandy Creek, N. Y., Wood Mfg. Co.......... Sandy Creek.

### VEHICLES AND VEHICLE PARTS.

Horton Lumber Co.......... Altmar.
Denton & Son.......... Oswego.
F. L. Raymond.......... Oswego.
W. M. Wilder.......... Pulaski.

### WOODENWARE AND NOVELTIES.

Charles Carpenter.......... Orwell.
Robert G. Potter.......... Orwell.
E. Dipse Furniture Co.......... Pulaski.
W. M. Wilder.......... Pulaski.

## OTSEGO COUNTY.

### AGRICULTURAL IMPLEMENTS.

C. F. Bushnell.................................. Gilbertsville.

### BASKETS AND FRUIT PACKAGES.

W. H. Rogers.................................. Wells Bridge.

### BOATS AND SHIPS.

H. E. Lewis & Co.............................. Cooperstown.

### BOXES AND CRATES, PACKING.

G. W. Ainslie.................................. Laurens.

### CHAIRS.

A. J. Benjamin.................................. Morris.
C. J. Armstrong & Sons........................ Milford.
C. J. Armstrong & Sons........................ Cherry Valley.

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

S. L. Kelsey.................................. Burlington.
Chase Mills and Supplies...................... Richfield Springs.
George N. Sides.............................. Schenevus.
G. W. Southworth.............................. West Exeter.

### EXCELSIOR.

George F. Lyon.............................. Milford.

### FURNITURE.

E. B. Clark.................................. Unadilla Forks.

### PLANING MILL PRODUCTS.

S. L. Kelsey.................................. Burlington.
H. E. Lewis & Co.............................. Cooperstown.
E. L. Ackerman.............................. Edmeston.
C. F. Naylor.................................. Hartwick.
G. W. Ainslie.................................. Laurens.
Burnside Bros.................................. Maryland.
Jones & Johnson.............................. Oaksville.
McFee & Borst.................................. Oneonta.
Richards & Son.................................. Oneonta.
Young, Beach & Maker.......................... Oneonta.
George N. Sides.............................. Schenevus.
Schuyler Lake Lumber Co...................... Schuyler Lake.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

C. J. Armstrong & Sons........................ Cherry Valley.
Robert Wales.................................. Cherry Valley.
N. H. Wikoff.................................. Cherry Valley.
F. M. Fox.................................. Colliersville.
John F. Brady & Co.......................... Cooperstown.
H. E. Lewis & Co.............................. Cooperstown.
E. L. Ackerman.............................. Edmeston.

### OTSEGO COUNTY — (Continued).

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

C. J. Armstrong.................................. Milford.
N. H. Briggs & Son.............................. Oneonta.
McFee & Borst.................................... Oneonta.
Chase Mills and Supplies........................ Richfield Springs.
C. H. Backus..................................... Unadilla Forks.
Hadsell Bros...................................... Worcester.

TANKS AND SILOS.

C. F. Bushnell.................................... Gilbertsville.
Adelbert Weller .................................. Salt Springville.
J. W. Van Cott & Son............................ Unadilla.

TOYS.

C. J. Armstrong & Sons.......................... Cherry Valley.
C. J. Armstrong & Sons.......................... Milford.

VEHICLES.

Adelbert Weller .................................. Salt Springville.

WOODENWARE AND NOVELTIES.

R. R. Ripley...................................... Morris.

## PUTNAM COUNTY.

PLANING MILL PRODUCTS.

Pendleton & Townsend............................ Patterson.

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Pendleton & Townsend............................ Patterson.
G. B. Hubble...................................... Brewster.

WOODENWARE AND NOVELTIES.

Mrs. L. Marta..................................... Mahopac.

## QUEENS COUNTY.

AEROPLANES.

International Aeronautic Construction Co.......... Jamaica.

BOAT AND SHIP BUILDING.

Patrick Ward & Co................................ Astoria.
Welin Marine Equipment Co....................... Long Island City.

BOXES AND CRATES, PACKING.

General Vehicle Co............................... Long Island City
LaLance & Grosjean Mfg. Co...................... Woodhaven.

CAR CONSTRUCTION.

Long Island Railroad (Richmond Hill branch) car shops ........................................ Jamaica.

## QUEENS COUNTY — (Continued).

### CASKETS AND COFFINS.

| | |
|---|---|
| Morgan Casket Co. | Brooklyn. |
| New York and Brooklyn Casket Co. | Brooklyn. |

### CHAIRS.

| | |
|---|---|
| Gott-Weber & Co. | Brooklyn. |
| The Adler Veneer Seat Co. | Long Island City. |

### FIXTURES.

| | |
|---|---|
| American Show Case Co. | Brooklyn. |
| Frederick Efflein & Sons. | Brooklyn. |
| C. B. French Cabinet Co. | Brooklyn. |
| Grenier Construction Co. | Brooklyn. |
| E. Hamburger & Co. | Brooklyn. |
| F. H. Helford & Co. | Brooklyn. |
| Manhattan Cabinet Works. | Brooklyn. |
| Schwartz & Co. | Brooklyn. |
| N. S. Scott Co. | Brooklyn. |
| William F. Worn & Co. | Brooklyn. |

### FURNITURE.

| | |
|---|---|
| Tisdale Lumber Co. | Astoria. |
| Mullin, Wagner & Co. | Coney Island. |
| DeLong Woodworking Co. | Long Island City. |
| Klein Bros. | Long Island City. |
| Le Gana & Co. | Long Island City. |
| American Parlor Frame Co. | Brooklyn. |
| Gluck Bros. | Brooklyn. |
| Gottl-Weber & Co. | Brooklyn. |
| Edw. B. Jordan & Co. | Brooklyn. |
| Manhattan Mantel Co. | Brooklyn. |
| C. H. Medicus & Son. | Brooklyn. |
| National Parlor Suit Co. | Brooklyn. |
| M. Neufeld & Sons, Inc. | Brooklyn. |
| Raymond Table Co. | Brooklyn. |
| Romer Mfg. Co. | Brooklyn. |
| F. Schneider & Sons. | Brooklyn. |
| Standard Wood Turning Co. | Brooklyn. |
| J. Stein & Son. | Brooklyn. |
| Thompson & Co. | Brooklyn. |
| W. W. Vredenburgh. | Brooklyn. |

### GATES AND FENCING.

| | |
|---|---|
| Kraemer Bros. Co. | College Point. |

### MUSICAL INSTRUMENTS.

| | |
|---|---|
| Eifert & Stoehr. | Long Island City. |

### PATTERNS AND FLASKS.

| | |
|---|---|
| General Vehicle Co. | Long Island City. |

## QUEENS COUNTY — (Continued).

### PLANING MILL PRODUCTS.

Kraemer Bros. Co. .......... College Point.
Charles Grabbe Co. .......... Rockaway Beach.
Alexander Piercey .......... Jamaica.
James H. Stansbury. .......... Jamaica.
Tisdale Lumber Co. .......... Astoria.
Thomas Pepper .......... Far Rockaway.
George Kaiser Lumber Co. .......... Far Rockaway.
William Schoncke .......... Far Rockaway.
D. M. Dibble Sons. .......... Tannersville.
Doncaster Planing Mill Co. .......... Long Island City.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Kraemer Bros. Co. .......... College Point.
United States Metal Products Co. .......... College Point.
John R. Carpenter. .......... Jamaica.
W. C. Hangoard Co. .......... Richmond Hill.
C. W. Copp. .......... Flushing.
Tisdale Lumber Co. .......... Astoria.
DeLong Woodworking Co. .......... Long Island.
The Kalamen Co. .......... Long Island.
Manhattan Grill and Fret Works Co. .......... Long Island.
Charles Crabbe Co. .......... Rockaway Beach.
Mullin, Wagner & Co. .......... Coney Island.

### SIGNS AND SUPPLIES.

Shaw Woodworking Co. .......... Brooklyn.

### VEHICLES AND VEHICLE PARTS.

Thomas Callister .......... Queens.
Brewster & Co., Inc. .......... Long Island City.
General Vehicle Co. .......... Long Island City.
Joseph Huber .......... Long Island City.

### WOODENWARE AND NOVELTIES.

B. Howard .......... Tannersville.

## RENSSELAER COUNTY.

### AGRICULTURAL IMPLEMENTS.

W. A. Wood Mowing and Reaping Machine Co. .......... Hoosick Falls.
Snyder Combined Thresher Co. .......... Troy.

### BASKETS AND FRUIT PACKAGES.

A. L. Harris. .......... East Nassau.

### BOXES AND CRATES, PACKING.

W. J. Cowee. .......... Berlin.
A. C. Cheney Piano Action Co. .......... Castleton.
Walter A. Wood Mowing and Reaping Machine Co. .......... Hoosick Falls.
Grubb & Koegarten Bros. .......... Nassau.
Frank C. Huyck & Sons. .......... Rensselaer.

**RENSSELAER COUNTY — (Continued).**

BOXES AND CRATES, PACKING.

| | |
|---|---|
| Cluett, Peabody & Co | Troy. |
| Troy Box and Lumber Co | Troy. |
| United Shirt and Collar Co | Troy. |

BRUSHES AND BROOMS.

| | |
|---|---|
| A. L. Sonn Brush Co | Troy. |

CHAIRS.

| | |
|---|---|
| A. L. Harris | East Nassau. |
| Henry Schneider & Co | Troy. |

FURNITURE.

| | |
|---|---|
| Cluett, Peabody & Co | Troy. |
| Henry Schneider & Co | Troy. |

INSTRUMENTS, MUSICAL.

| | |
|---|---|
| A. C. Cheney Piano Action Co | Castleton. |
| Grubb & Kosegarten Bros | Nassau. |
| A. D. Beach | Troy. |

LAUNDRY APPLIANCES.

| | |
|---|---|
| Cluett, Peabody & Co | Troy. |

MACHINE CONSTRUCTION.

| | |
|---|---|
| Noble & Wood Machine Co | Hoosick Falls. |

PATTERNS AND FLASKS.

| | |
|---|---|
| Noble & Wood Machine Co | Hoosick Falls. |
| Cluett, Peabody & Co | Troy. |

PLANING MILL PRODUCTS.

| | |
|---|---|
| Frank Richler | Grafton. |
| Charles C. Kantz | Johnsonville. |
| D. B. Stevens | Johnsonville. |
| Cluett, Peabody & Co | Troy. |
| United Shirt and Collar Co | Troy. |

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

| | |
|---|---|
| D. B. Stevens | Johnsonville. |
| Madden Lumber Co | Troy. |

SHUTTLES, SPOOLS, BOBBINS.

| | |
|---|---|
| Frary Spool Co | Berlin. |

TANKS AND SILOS.

| | |
|---|---|
| D. B. Stevens | Johnsonville. |

TOYS.

| | |
|---|---|
| A. C. Cheney Piano Action Co | Castleton. |

VEHICLES.

| | |
|---|---|
| George Sullivan Mfg. Co | Troy. |
| Troy Carriage Works | Troy. |

## RICHMOND COUNTY.

### BOAT AND SHIP BUILDING.

| | |
|---|---|
| S. F. Bannar | Marines' Harbor. |
| Brewer Dry Dock Co | Marines' Harbor. |
| Caddell Bros. | Marines' Harbor. |
| Alexander MacDonald | Marines' Harbor. |
| A. C. Brown Sons. | Tottenville. |
| Harry E. Cossey | Tottenville. |
| Jacob S. Elias & Sons | Tottenville. |
| Waters Calver Co | W. New Brighton. |
| Frank McWilliams, Inc | W. New Brighton. |

### CHAIRS.

| | |
|---|---|
| Barnaby Furniture Co., Inc | Stapleton. |

### FURNITURE.

| | |
|---|---|
| Barnaby Furniture Co., Inc | Stapleton. |
| William C. Van Clief | Port Richmond. |

### HANDLES.

| | |
|---|---|
| Richmond Broom Co | Stapleton. |

### PATTERNS AND FLASKS.

| | |
|---|---|
| Milliken Bros. | Milliken. |

### PLANING MILL PRODUCTS.

| | |
|---|---|
| William C. Van Clief | Port Richmond. |
| Willard Conklin | Port Richmond. |

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

| | |
|---|---|
| William C. Van Clief | Port Richmond. |
| Willard Conklin | Port Richmond. |
| Nicholas Lauterbach | Stapleton. |
| Louis Scherer | Stapleton. |

### VEHICLES AND VEHICLE PARTS.

| | |
|---|---|
| Zoin Scheengauer | Stapleton. |

### WHIPS, CANES AND UMBRELLA STICKS.

| | |
|---|---|
| J. Sarver | Stapleton. |

### WOODENWARE AND NOVELTIES.

| | |
|---|---|
| Jaburg Mfg. Co. | Stapleton. |

## ROCKLAND COUNTY.

### BOXES AND CRATES, PACKING.

Martin & Stecher.................................. Nanuet.

### BRUSHES AND BROOMS.

Oskar Martin .................................. Nanuet.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Clark & Bennett Lumber Co........................ Haverstraw.

### TOYS.

Oskar Martin .................................. Nanuet.

### WOODENWARE AND NOVELTIES.

Martin & Stecher.................................. Nanuet.

## ST. LAWRENCE COUNTY.

### AGRICULTURAL IMPLEMENTS.

P. E. Kinnehan.................................. Brasher Falls.
B. A. Evans.................................. Hammond.

### BASKETS AND FRUIT PACKAGES.

J. Leef .................................. Rossie.

### BOAT AND SHIP BUILDING.

St. Lawrence Marine Railway Co.................. Ogdensburg.

### BOOT AND SHOE FINDINGS.

Wanakena Last Co.................................. Wanakena.

### BOXES AND CRATES, PACKING.

Racine Thompson .................................. De Peyster.
Remington-Martin Co.................................. Norfolk.
Morrison Blair .................................. Rensselaer Falls.
C. G. & J. R. Wellington.......................... West Stockholm.

### BRUSHES AND BROOMS.

United States Brush Co.......................... Potsdam.

### CASKETS AND COFFINS.

M. B. Hawley.................................. Colton.
Norwood Casket Co.................................. Norwood.

### CHAIRS.

Wright Convertible Chair Co...................... Madrid.

## ST. LAWRENCE COUNTY — (Continued).

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

H. Wallace & Son.......... Canton.
C. E. Giffin.......... De Peyster.
Racine Thompson.......... De Peyster.
A. E. Ober.......... Fort Jackson.
Hollenbeck & Coolidge.......... Ogdensburg.
Landon & Greene.......... Parishville.
Morrison & Blair.......... Rensselaer Falls.
George N. Gibson & Son.......... West Stockholm.

### EXCELSIOR.

The Edwards Excelsior Mills.......... Edwards.

### PICTURE FRAMES AND MOULDINGS.

United States Brush Co.......... Potsdam.

### FURNITURE.

M. B. Hawley.......... Colton.
University Woodworking Co.......... Colton.
R. J. Fairbanks & Sons.......... Hermon.
Batchelder & Sons.......... Potsdam.
Grant St. Planing Mill Co.......... Potsdam.
George N. Gibson & Son.......... West Stockholm.

### INSTRUMENTS, MUSICAL.

Clifton Library Co.......... Benson Mines.

### PATTERNS AND FLASKS.

P. E. Kennehan.......... Brasher Falls.

### PLANING MILL PRODUCTS.

Bucks Bridge Lumber Co.......... Canton.
Judd W. Rushton.......... Canton.
C. Van Ornum.......... Degrasse.
Lemuel Clark.......... DeKalb Junc.
Horace Beach & Son.......... Edwards.
Woodcock Bros.......... Edwards.
Fred A. Stevens.......... Fine.
A. E. Ober.......... Fort Jackson.
J. H. Carpenter.......... Hailesboro.
William Soper.......... Hammond.
Murray A. Babcock.......... Hermon.
W. H. Thompson.......... Kokomo.
David Crump.......... Madrid.
Perkins Lockwood.......... Madrid.
J. E. Thompson.......... Madrid.
Gillis Bros.......... Morristown.
J. R. Richardson & Son.......... North Lawrence.
R. D. Reed.......... Norwood.
H. Nelson Brown.......... Ogdensburg.
Skilling's, Whitney's & Barnes' Lumber Co.......... Ogdensburg.

## ST. LAWRENCE COUNTY — (Continued).

### PLANING MILL PRODUCTS.

| | |
|---|---|
| C. Colton | Oswegatchie. |
| The A. Sherman Lumber Co | Potsdam. |
| Wheater & Johnson | Rensselaer Falls. |
| A. A. Gates | Richville. |
| Henry Burdick | Waddington. |
| Rutherford & Dunn | Waddington. |
| Rich Lumber Co | Wanakena. |
| George N. Gibson & Son | West Stockholm. |

### PUMPS.

| | |
|---|---|
| William C. Hill | Brasher Falls. |
| A. A. Babcock Pump Co | Ogdensburg. |

### SHADE AND MAP ROLLERS.

| | |
|---|---|
| Flos Shade Roller Co | Ogdensburg. |

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

| | |
|---|---|
| Fred N. Capell | Brasher Falls. |
| Gardner & Veitch | Canton. |
| Judd W. Rushton | Canton. |
| Murray A. Babcock | Hermon. |
| W. L. Pratt | Massena. |
| Fred J. Petrie | Morristown. |
| Plumb & Cochrane Co | Norfolk. |
| James R. Richardson & Son | North Lawrence. |
| R. D. Reed | Norwood. |
| H. Nelson Brown | Ogdensburg. |
| Landon & Green | Ogdensburg. |
| Proctor Mfg. Co | Ogdensburg. |
| W. J. Pooler | Ogdensburg. |
| Grant St. Planing Mill | Potsdam. |
| A. A. Gates | Richville. |
| George N. Gibson & Son | West Stockholm. |

### VEHICLES AND VEHICLE PARTS.

| | |
|---|---|
| M. B. Hawley | Colton. |
| B. A. Evans | Hammond. |
| A. W. Phillips | Hopkinton. |
| David Crump | Madrid. |
| Perkins Lockwood | Madrid. |
| Plumb & Cochrane Co | Norfolk. |

### WHIPS, CANES AND UMBRELLA STICKS.

| | |
|---|---|
| J. W. Ventres & Co | Wanakena. |

### WOODENWARE AND NOVELTIES.

| | |
|---|---|
| R. J. Fairbanks | Hermon. |

## SARATOGA COUNTY.

### BASKETS AND FRUIT PACKAGES.

Garnsey Wood .................................. Elnora.

### BOAT AND SHIP BUILDING.

John S. Jones.................................. Greenfield Center.
Henry A. Hart.................................. Hagedorns Mills.
William Barker ................................ Mechanicville.
West Virginia Pulp and Paper Co................ Mechanicville.
John J. Koons.................................. Saratoga Springs.
W. H. Martin................................... Saratoga Springs.

### CAR CONSTRUCTION.

Boston and Maine Railroad Shops................ Mechanicville.

### CHAIRS.

E. H. Benway & Co.............................. Corinth.
Walter Stone & Co.............................. Hadley.
O. E. Sism..................................... Hagedorn's Mills.

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

John J. Koons.................................. Saratoga Springs.

### EXCELSIOR.

E. H. Penway & Co.............................. Corinth.

### HANDLES.

J. D. Mulernan................................. Hadley.

### PLANING MILL PRODUCTS.

E. A. Curtis................................... Ballston.
C. L. Dows..................................... Clifton Park.
Rhodes & Johnson............................... Conklingville.
H. W. Mastin................................... East Galway.
William Barber ................................ Mechanicville.
T. C. Luther................................... Mechanicville.
A. D. Strang................................... Mechanicville.
Wilfred Colburn ............................... Middle Grove.
William J. Case & Sons......................... Saratoga Springs.
Funston Bros................................... Schuylerville.
Max Richter ................................... Ushers.
Seymour Ruggles ............................... Wilton.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Dennis Manogue ................................ Ballston.
Striever Lumber Co............................. Ballston.
Henry W. Mastin................................ East Galway.
William Barber ................................ Mechanicville.
A. D. Strang................................... Mechanicville.
H. J. Hammond.................................. Saratoga Springs.

SARATOGA COUNTY — (Continued).

TANKS AND SILOS.

Saratoga Silo Mfg. Co. .......... Saratoga Springs.

VEHICLES.

Henry W. Mastin .......... East Galway.
C. E. Palmer .......... Saratoga Springs.
Max Richter .......... Ushers.
Steinbergh Bros. .......... Waterford.

## SCHENECTADY COUNTY.

AGRICULTURAL IMPLEMENTS.

Westinghouse Co. .......... Schenectady.

BOXES AND CRATES, PACKING.

General Electric Co. .......... Schenectady.

CAR CONSTRUCTION.

American Locomotive Co. .......... Schenectady.

FIXTURES.

Richard Wickham, Jr. .......... Schenectady.

FURNITURE.

Simmons & Merwin .......... Stanford.

PATTERNS AND FLASKS.

American Locomotive Co. .......... Schenectady.
General Electric Co. .......... Schenectady.
Westinghouse Co. .......... Schenectady.

PLANING MILL PRODUCTS.

Hunt & Washburn .......... Delanson.
Peckham, Wolf & Co. .......... Schenectady.
Brown & Walker Lumber and Construction Co. .......... Schenectady.

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Veeder & Brown .......... Schenectady.

VEHICLES.

E. Loucks & Co. .......... Schenectady.

## SCHOHARIE COUNTY.

AGRICULTURAL IMPLEMENTS.

S. K. Campbell Co., Ltd. .......... Central Bridge.
Harder Mfg. Co. .......... Cobleskill.

BOXES AND CRATES, PACKING.

G. Gale & Son .......... Barnerville.
Charles Quackenbush .......... Barnerville.
F. L. Casper & Son .......... Howe Cave.

## SCHOHARIE COUNTY — (Continued).

### CAR CONSTRUCTION.

Creek Lumber Co.............................. Middleburg.

### CHAIRS.

Creek Lumber Co.............................. Middleburg.

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

G. Gale & Son.............................. Barnerville.
C. Quackenbush.............................. Barnerville.

### FURNITURE.

F. L. Casper & Sons.............................. Howe Cave.
William Almy.............................. Middleburg.
Creek Lumber Co.............................. Middleburg.

### PLANING MILL PRODUCTS.

M. L. Wofford & Son.............................. Breakabeen.
H. D. Karker & Co.............................. Cobleskill.
Elaine W. Haverley.............................. Gallupville.
Brown Bros.............................. Hyndsville.
William Almy.............................. Middleburg.
Creek Lumber Co.............................. Middleburg.
S. C. West.............................. Middleburg.
Lewis Gillette.............................. Richmondville.
Bursley Merenes.............................. Seward.
M. S. Faulkner.............................. West Conesville.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

H. D. Karker & Co.............................. Cobleskill.
William Almy.............................. Middleburg.
Goodrich Factory.............................. Middleburg.
S. C. West.............................. Middleburg.
Bursley Merenes.............................. Seward.
C. MacFee.............................. Seward.
LeRoy Rowley.............................. Sloansville.

### TANKS AND SILOS.

Goodrich Factory.............................. Middleburg.
Daniel Vunk.............................. Sloansville.

### VEHICLES.

W. E. Warner.............................. Schoharie.

## SCHUYLER COUNTY.

### BASKETS AND FRUIT PACKAGES.

F. Washburg .................................... Alpine.
F. Swick ........................................ Reynoldville.
George W. Burr.................................. Valois.
W. H. Wardner.................................. Valois.
William Brimmer ................................ Wayne.
A. K. Smith's Federal Crate and Basket Co........ Watkins.

### BOATS AND SHIPS.

W. F. Summer.................................... Wayne.

### BOXES AND CRATES, PACKING.

Shepard Electric Crane and Hoist Co.............. Montour Falls.
Odessa Mfg. Co.................................. Odessa.

### FIXTURES.

Fixture and Lumber Co........................... Watkins.

### MACHINE CONSTRUCTION.

Shepard Electric Crane and Hoist Co.............. Montour Falls.

### PATTERNS AND FLASKS.

Shepard Electric Crane and Hoist Co.............. Montour Falls.

### PLANING MILL PRODUCTS.

F. C. Campbell.................................. Alpine.
Irwin Dunham .................................... Burdett.
D. C. Blair...................................... Montour Falls.
C. B. Rhodes.................................... Moreland Station.
N. F. DeWitt.................................... Odessa.
Fixture and Lumber Co........................... Watkins.
George Bliss .................................... Wayne.

### WOODENWARE AND NOVELTIES.

Odessa Mfg. Co.................................. Odessa.

## SENECA COUNTY.

### BASKETS AND FRUIT PACKAGES.

Weager & Grove.................................. Interlaken.
William Bailey .................................. Lodi.

### BOXES AND CRATES.

The Gould Mfg. Co............................... Seneca Falls.
Rumsey & Co., Ltd............................... Seneca Falls.
Waterloo Wagon Co............................... Waterloo.

### HANDLES.

Rumsey & Co., Ltd............................... Seneca Falls.

**SENECA COUNTY — (Continued).**

INSTRUMENTS, PROFESSIONAL.

National Advertising Co.......................... Seneca Falls.
Westcott-Jewell Co.............................. Seneca Falls.

PATTERNS AND FLASKS.

The Gould Mfg. Co.............................. Seneca Falls.
Rumsey Co., Ltd................................ Seneca Falls.

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Waterloo Sash and Door Co....................... Waterloo.

TOYS.

National Advertising Co.......................... Seneca Falls.

VEHICLES.

Glen Wagon Co.................................. Seneca Falls.
Waterloo Wagon Co.............................. Waterloo.

## STEUBEN COUNTY.

AGRICULTURAL IMPLEMENTS.

J. S. Harrison & Co............................. Addison.

BASKETS AND FRUIT PACKAGES.

B. F. Dailey & Sons............................. Atlanta.
E. H. Dudley & Co.............................. Cameron & Bath.
Hadley Bros..................................... Cameron & Bath.
Canisteo Woodenware Co......................... Canisteo.
Superior Register Co............................ Canisteo.
F. W. Barker................................... Coopers Plains.
H. H. Littur.................................... Coopers Plains.
D. E. Drake..................................... Jasper.
W. B. Pierce & Co.............................. Pulteney.
A. K. Young.................................... Pulteney.

BOXES AND CRATES, PACKING.

Smith Bros...................................... Addison.
A. M. Eiland................................... Arkport.
Raymond Mfg. Co................................ Bath.
F. P. Lindeman Furniture Co..................... Cameron.
Steuben Lumber and Furniture Co................. Canisteo.
Hammondsport Box Factory........................ Hammondsport.
J. M. Deutsch Co............................... Hornell.
McConnell Mfg. Co.............................. Hornell.
Ingersoll Rand Co............................... Painted Post.
Charles B. Davis................................ Savona.
Plail Bros...................................... Wayland.

CHAIRS.

W. H. Gunlocks Chair Co......................... Wayland.
Plail Bros...................................... Wayland.

DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

W. O. Slocum................................... Greenwood.

## STEUBEN COUNTY — (Continued).

### DOWELS.

Plail Bros.......... Wayland.

### EXCELSIOR.

F. P. Linderman & Son.......... Cameron.

### FURNITURE.

Jones Bros. & Parker.......... Bath.
Raymond Mfg. Co.......... Bath.
J. M. Deutsch Co.......... Hornell.
Plail Bros.......... Wayland.

### MACHINERY AND APPARATUS, ELECTRICAL.

Avoca Mfg. Co.......... Avoca.

### PATTERNS AND FLASKS.

E. R. Allen Foundry Co.......... Painted Post.

### PLANING MILL PRODUCTS.

W. E. Griffiths.......... Addison.
Smith Bros.......... Addison.
Jones Bros. & Parker.......... Bath.
Alfred Slawson.......... Canisteo.
The Corning Building Co.......... Corning.
G. M. Woodward.......... Greenwood.
McConnell Mfg. Co.......... Hornell.
Walrath Bros. & Wentworth.......... Jasper.
Painted Post Lumber Co.......... Painted Post.
T. E. Ringrose.......... Prattsburg.
The J. H. Strait Mfg. Co.......... Rexville.
Charles B. Davis.......... Savona.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Park, Winton & True Co.......... Addison.
Jones Bros. & Parker.......... Bath.
Corning Bldg. Co.......... Corning.
Warner & Phillips.......... Corning.
G. M. Woodward.......... Greenwood.
J. M. Deutsch Mfg. Co.......... Hornell.
McConnell Mfg. Co.......... Hornell.
Lane Bridge Co.......... Painted Post.
T. E. Ringrose.......... Prattsburg.
A. Gleason.......... Troupsburg.
Wolff Lumber Co.......... Wayland.

### VEHICLES.

J. S. Harrison & Co.......... Addison.
B. F. Dailey & Son.......... Atlanta.
Avoca Wheel Co.......... Avoca.
Jason Weeks.......... Greenwood.

### WOODENWARE AND NOVELTIES.

W. W. Babcock Co.......... Bath.
F. W. Barker.......... Cooper's Plains.

## SUFFOLK COUNTY.

### BOAT AND SHIP BUILDING.

| | |
|---|---|
| Rubin Miller | Amagansett. |
| Wood Lumber Co. | Amityville. |
| Willard F. Downs | Bay Shore. |
| Albert V. Rogers | Bay Shore. |
| H. V. Watkins | Bellport. |
| Walter E. Abrams | Cold Spring Harbor. |
| J. Newton Hand | East Moriches. |
| Otis Sinclair & Co. | Good Ground. |
| Albertson Construction Co. | Greenport. |
| Fred C. Beebe | Greenport. |
| Eastern Shipyard Co. | Greenport. |
| Greenport Basin and Construction Co. | Greenport. |
| J. W. Ketcham | Greenport. |
| Tutthil & Thorn | Greenport. |
| Atkin-Wheeler Co. | Huntington. |
| Carter & Son | Jamesport. |
| Elmer D. Tuthill | Mattituck. |
| Jesse Carll | Northport. |
| Fillmore A. Baker | Patchogue. |
| George D. Bishop | Patchogue. |
| DeWitt C. Conklin | Patchogue. |
| G. M. Smith | Patchogue. |
| Martenus Smith | Patchogue. |
| S. C. Weeks & Co. | Patchogue. |
| James M. Bayles & Son | Port Jefferson. |
| D. B. Campbell | Port Jefferson. |
| John F. Hawkins | Port Jefferson. |
| G. H. Cleveland | Sag Harbor. |
| Daniel M. Corwin | South Jamesport. |
| Jelle Dykstra | West Sayville. |
| J. E. Rudolph | West Sayville. |

### BOXES AND CRATES, PACKING.

| | |
|---|---|
| Joseph Fahys & Co. | Sag Harbor. |

### CASKETS AND COFFINS.

| | |
|---|---|
| William Bihl | Central Islip. |

### FIXTURES.

| | |
|---|---|
| Chris S. Mergell | Amityville. |

### PATTERNS AND FLASKS.

| | |
|---|---|
| Joseph Fahys & Co | Sag Harbor. |

### PLANING MILL PRODUCTS.

| | |
|---|---|
| Wood Lumber Co. | Amityville. |
| William Bihl | Central Islip. |
| Jones Bros. | Port Jefferson. |
| G. H. Cleveland | Sag Harbor. |
| Joseph Fahys & Co. | Sag Harbor. |
| D. F. Bayles & Sons | Stony Brook. |

**SUFFOLK COUNTY — (Continued).**

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

| | |
|---|---|
| Chris S. Mergell | Amityville. |
| Charles Wood & Co | Babylon. |
| Charles E. Kirkup | Bay Shore. |
| William Bihl | Central Islip. |
| East Hampton Lumber and Coal Co | East Hampton. |
| Irving W. Tenhill | East Marion. |
| Henry W. Burt | East Northport. |
| C. A. Corwin | Greenport. |
| C. V. Fanning | Greenport. |
| Joseph H. Sweezey | Greenport. |
| Huntington Sash and Door Co | Huntington. |
| Robertson Bros | Huntington. |
| Wines & Homan | Mattituck. |
| Hudson & Co | Mattituck. |
| The Northport Lumber and Coal Co | Northport. |
| E. Bailey & Sons, Inc | Patchogue. |
| Loper Bros | Port Jefferson. |
| Charles Skidmore | Riverhead. |
| G. H. Cleveland | Sag Harbor. |
| Joseph Fahys & Co | Sag Harbor. |
| F. G. Booth | Smithtown Branch. |
| E. O. Fordham | Speonk. |
| D. F. Bayles & Son | Stony Brook. |

TANKS AND SILOS.

| | |
|---|---|
| Joseph Fahys & Co | Sag Harbor. |

VEHICLES AND VEHICLE PARTS.

| | |
|---|---|
| H. V. Watkins | Bellport. |
| Robertson Bros | Huntington. |
| A. Bentley | Port Jefferson. |
| Only Motor Car Co | Port Jefferson Station. |
| D. F. Bayles & Sons | Stony Brook. |

## SULLIVAN COUNTY.

BASKETS AND FRUIT PACKAGES.

| | |
|---|---|
| Fred Wildey | Livingston. |

BOAT AND SHIP BUILDING.

| | |
|---|---|
| William Knapp | Narrowsburg. |

BOXES AND CRATES, PACKING.

| | |
|---|---|
| S. N. Smith & Son | Eureka. |

BRUSHES AND BROOMS.

| | |
|---|---|
| Henry Peake | Long Eddy. |
| Henry Peck | Long Eddy. |

## SULLIVAN COUNTY — (Continued).

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

Gould Lumber Co ............ Long Eddy.

### EXCELSIOR.

H. J. Weiden ............ Neweiden.

### FURNITURE.

The W. Hoffer Furniture Co ............ Cohoes.
W. A. Briggs ............ Cohoes.
Holloway Library Co ............ Eldred.
Koons Bros ............ Grooville.
Koons & Co ............ Livingston Manor.
Gould Lumber Co ............ Long Eddy.

### PLANING MILL PRODUCTS.

T. E. Davis ............ Clayville.
W. A. Briggs ............ Clayville.
George B. Reynolds ............ Grahamsville.
William Kohler ............ Jeffersonville.
F. S. Grant ............ Liberty.
Robert Kinne ............ Liberty.
A. M. Chandler ............ Long Eddy.
Gould Lumber Co ............ Long Eddy.
Henry Peak ............ Long Eddy.
J. T. Pethick ............ Narrowsburg.
George L. Klinger ............ North Branch.
Levi Countryman ............ No. White Lake.
Roy K. Hall ............ No. White Lake.
Charles Winters ............ No. White Lake.
Isaac I. Watson ............ Roscoe.
S. A. Adams ............ Summitville.
Martin Herman ............ Callicoon.
Holloway Lumber Co ............ Eldred.
J. T. Greig ............ Eldred.
H. & J. G. Love ............ Eldred.
Willard Wells & Son ............ Eldred.
A. S. Swan ............ Stevensville.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Martin Herman ............ Callicoon.
W. A. Briggs ............ Clayville.
S. W. Smith & Son ............ Eureka.
Edward Hope ............ Hurleyville.
E. Seibert ............ Hurleyville.
F. S. Grant ............ Liberty.
Gurnsey Rampe ............ Liberty.
P. H. Woolsey & Co ............ Livingston Manor.
Henry Peake ............ Long Eddy.

## SULLIVAN COUNTY — (Continued).

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

A. M. Chandler.......... Long Eddy.
I. O. Smith.......... Monticello.
Stephen Trowbridge .......... Monticello.
Henry Washington .......... Monticello.
Henry W. Whipple.......... Monticello.
J. T. Petheck.......... Narrowsburg.
George L. Klinger.......... North Branch.
Walter Sherwood .......... Roscoe.
Isaac P. Watson.......... Roscoe.
Frederick Olmstead .......... South Fallsburg.
John Weber .......... Yulan.

### PLANING MILL PRODUCTS.

Holloway Lumber Co.......... Barryville.
John R. Ness & Co.......... Beaver Brook.

### SHUTTLES, SPOOLS, BOBBINS

Frederick Olmstead .......... South Fallsburg.

### SPORTING AND ATHLETIC GOODS.

Retter Ainslie .......... Roscoe.

### TOYS.

August Guntlow, Jr.......... Woodbourne.

### VEHICLES.

John P. Smith.......... No. White Lake.
J. J. Misner.......... Woodbourne.

### WOODENWARE AND NOVELTIES

Edward Hope .......... Hurleyville.
E. Seibert .......... Hurleyville.
August Guntlow, Jr.......... Woodbourne.

## TIOGA COUNTY.

### AGRICULTURAL IMPLEMENTS.

International Harvester Co.......... Newark Valley.
Fred Greene .......... Richford.

### BASKETS AND FRUIT PACKAGES.

Howland Bros.......... Berkshire.

### BOXES AND CRATES, PACKING

S. W. Johnson & Sons.......... Nichols.

### BRUSHES AND BROOMS.

S. W. Johnson & Son.......... Nichols.

## TIOGA COUNTY — (Continued).

### FURNITURE.

S. W. Johnson & Sons .......... Nichols.
Hall & Lyon Furniture Co .......... Waverly.

### LAUNDRY APPLIANCES.

Howland Bros .......... Berkshire.

### MACHINERY AND APPARATUS, ELECTRICAL.

S. W. Johnson & Sons .......... Nichols.

### PLANING MILL PRODUCTS.

Frank Palmer & Son .......... Apalachin.
Howland Bros .......... Berkshire.
Booth Bros .......... Candor.
Ellis & Moore .......... Candor.
M. J. Clark .......... Newark Valley.
Fred Greene .......... Tioga.
Volbrecht & Wild .......... Spencer.
H. J. Baldwin & Son .......... Waverly.

### PLAYGROUND EQUIPMENT.

James F. Wilbur .......... Berkshire.

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

S. W. Johnson & Son .......... Nichols.

### TOYS.

James F. Wilbur .......... Berkshire.

### WOODENWARE NOVELTIES.

S. W. Johnson & Son .......... Nichols.

## TOMPKINS COUNTY.

### AGRICULTURAL IMPLEMENTS.

William Hasard .......... Trumansburg.

### BOXES AND CRATES, PACKING.

Monarch Road Roller Co .......... Groton.
Groton Typewriter Co .......... Groton.

### CLOCKS.

Ithaca Calendar Clock Co .......... Ithaca.

### FIREARMS.

Ithaca Gun Co .......... Ithaca.

### FURNITURE.

Cornell University .......... Ithaca.

### INSTRUMENTS, MUSICAL.

The Autophone Co .......... Ithaca.

**TOMPKINS COUNTY — (Continued).**

INSTRUMENTS, PROFESSIONAL.

Stanford-Crowell Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Ithaca.

MACHINE CONSTRUCTION.

Monarch Road Roller Co. . . . . . . . . . . . . . . . . . . . . . . . . . Groton.
Williams Bros. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Ithaca.

PATTERNS AND FLASKS.

Monarch Road Roller Co. . . . . . . . . . . . . . . . . . . . . . . . . . Groton.

PLANING MILL PRODUCTS.

D. M. White. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Brockton.
H. H. Hunter. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Dryden.
T. R. Bryant. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Freeville.
F. T. Brock. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Ithaca.
Cornell University Rep. Dept. . . . . . . . . . . . . . . . . . . . . . Ithaca.
Fred Middaugh . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Ithaca.
Robinson & Carpenter. . . . . . . . . . . . . . . . . . . . . . . . . . . Ithaca.
H. S. Fuller. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . McLean.

SIGNS AND SUPPLIES.

Stanford-Crowell Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Ithaca.

TANKS AND SILOS.

Driscoll Bros. & Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . Ithaca.

VEHICLES.

Charles Bartholomew . . . . . . . . . . . . . . . . . . . . . . . . . . . Etna.
George S. Morris. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Ithaca.
Pritchard & Sons. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Ithaca.
H. S. Fuller. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . McLean.

WOODENWARE AND NOVELTIES.

T. R. Bryant. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Freeville.

## ULSTER COUNTY.

AGRICULTURAL IMPLEMENTS

Hendricks Hay Press Co. . . . . . . . . . . . . . . . . . . . . . . . . . Kingston.

BASKETS AND FRUIT PACKAGES.

M. A. Presler. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Highland.
J. E. Westcott. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Highland.
A. D. Relyea. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . New Paltz.
E. E. Wyget. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Marlboro.

BOAT AND SHIP BUILDING.

C. Hildebrant Dry Dock Co. . . . . . . . . . . . . . . . . . . . . . . Connelly.
John S. Baisden & Co. . . . . . . . . . . . . . . . . . . . . . . . . . . Kingston.
R. Lanehan Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Kingston.
Jacob Rice & Co. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Kingston.

## ULSTER COUNTY — (Cotinued).

### BOXES AND CRATES, PACKING.

| | |
|---|---|
| Big Indian Wood Products Co., Ltd | Big Indian. |
| Dwight Devine & Sons | Ellenville. |
| George W. Pratt & Son | Highland. |
| Hendricks Hay Press Co | Kingston. |
| Hercules Metal Corner Co | Kingston. |
| Traphagan & Hull Mfg. Co | Kingston. |
| Universal Road Machinery Co | Kingston. |
| Franklin Clark | Marlboro. |
| Augustine Kaley | Milton. |
| W. H. Townsend | Milton. |
| Pine Hill Crystal Spring Water Co | Pine Hill. |
| Maple Chair Co | Shandaken. |

### BRUSHES AND BROOMS.

| | |
|---|---|
| Herbert Brush Mfg. Co | Kingston. |

### CHAIRS.

| | |
|---|---|
| Frank Eckes Mfg. Co | Mt. Tremper. |
| Maple Chair Co | Shandaken. |

### DAIRYMEN'S, POULTERERS' AND APIARISTS' SUPPLIES.

| | |
|---|---|
| Edward Beadle | Boiceville. |

### EXCELSIOR.

| | |
|---|---|
| C. N. Morse | Lackawack. |
| Gormley Bros | Phoenicia. |
| Arthur V. Hornbeck | Warwarsing. |

### FIXTURES.

| | |
|---|---|
| William O. Schwarzwaelder | Chichester. |
| Vasburg Bros | Shady. |

### FURNITURE.

| | |
|---|---|
| William O. Schwarzwaelder | Chichester. |
| Traphagan & Hull Mfg. Co | Kingston. |
| Vasburg Bros | Shady. |

### HANDLES.

| | |
|---|---|
| Dwight Devine & Sons | Ellenville. |
| J. W. Elvey | Phoenicia. |

### MACHINE CONSTRUCTION.

| | |
|---|---|
| Universal Road Machinery Co | Kingston. |

### PATTERNS AND FLASKS.

| | |
|---|---|
| Dwight Devine & Sons | Ellenville. |
| Universal Road Machinery Co | Kingston. |
| James B. Crowell & Son | Walkill. |
| George B. Mentz Co | Walkill. |

## ULSTER COUNTY — (Continued).

### PLANING MILL PRODUCTS.

| | |
|---|---|
| P. H. Hendricks | Atwood. |
| A. A. Vandermark & Son | Atwood. |
| Big Indian Wood Products Co., Ltd | Big Indian. |
| William H. Deyo | Ellenville. |
| Frank Dixon | Ellenville. |
| M. E. Green | Kerhonkson. |
| James S. Van Etten | Kerhonkson. |
| Kingston Wood Working Co | Kingston. |
| Theodore Weeks | Kingston. |
| G. N. Morse | Lackawack. |
| F. J. Carpenter | Oxbow. |
| A. B. Fairbanks | Oxbow. |
| W. S. Fletcher | Oxbow. |
| William Simpson | West Shokan. |

### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

| | |
|---|---|
| William O. Schwarzwaelder | Chichester. |
| William H. Deyo | Ellenville. |
| Dwight Devine & Sons | Ellenville. |
| C. H. Sheeley | Ellenville. |
| A. R. Courtant | Kingston. |
| Albert Manderstock | Kingston. |
| J. A. Mulhern | Kingston. |
| H. W. Palen's Sons | Kingston. |
| J. W. Elvey | Phoenicia. |
| Vosburgh Bros | Shady. |

### SPORTING AND ATHLETIC GOODS.

| | |
|---|---|
| J. W. Elvey | Phoenicia. |

### VEHICLES AND VEHICLE PARTS.

| | |
|---|---|
| H. W. Sutton | Clintondale. |
| Hendricks Hay Press Co | Kingston. |
| John W. Mayer | Kingston. |
| J. W. Elvey | Phoenicia. |
| James B. Crowell & Son | Walkill. |
| George Siemon | West Shokan. |

### MISCELLANEOUS.

#### DYNAMITE.

| | |
|---|---|
| E. I. DuPont de Nemours Powder Co | Brown Station. |

## WARREN COUNTY.

### SHIP AND BOAT BUILDING.

Barber & Robinson.............................. Bolton Landing.
George Granger ................................ Bolton Landing.
Fred R. Smith.................................. Bolton Landing.
R. R. Norton................................... Glens Falls.

### BOXES AND CRATES, PACKING.

Kendrick & Brown Co............................ Glens Falls.
Rice & Woodward................................ Warrensburg.

### BRUSHES AND BROOMS.

Gifford Lumber Co.............................. Glens Falls.
John Morrison ................................. Glens Falls.

### CHAIRS.

A. D. Scribner................................. Stony Creek.
Walter Stone & Son............................. Stony Creek.

### EXCELSIOR.

L. L. Hall..................................... Knowelhurst.
Albert Scribner ............................... Knowelhurst.
North River Mfg. Co............................ North Creek.
Lee L. Hall.................................... Stony Creek.
A. D. Scribner................................. Stony Creek.
Harry Cunningham .............................. Warrensburg.

### FURNITURE.

Barber & Robinson.............................. Bolton Landing.

### HANDLES.

Lee L. Hall.................................... Stony Creek.

### PROFESSIONAL INSTRUMENTS.

Lee L. Hall.................................... Stony Creek.

### PLANING MILL PRODUCTS.

Bolton Landing Lumber Co....................... Bolton Landing.
Lemuel Maxim .................................. Chestertown.
J. F. Thurston................................. Chestertown.
Gifford Lumber Co.............................. Glens Falls.
Kendrick & Brown Co............................ Glens Falls.
Finch, Pruyn & Co., Inc........................ Glens Falls.
N. E. Yaw...................................... Hague.
William P. Hartman & Sons...................... Hartman.
Thomas Bolton, Jr.............................. Horicon.
Albert Scribner ............................... Knowelhurst.
G. R. Russell.................................. Lake George.
W. S. Worden................................... Lake George.
Fred Dingman .................................. Luzerne.
Stone Bros..................................... Luzerne.
C. S. Wood..................................... North Creek.
Lee L. Hall.................................... Stony Creek.
A. D. Scribner................................. Stony Creek.
Rice & Woodward................................ Warrensburg.
P. Morton's Sons............................... Wevertown.

**WARREN COUNTY** — (Continued).

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

| | |
|---|---|
| Charles Baker | Baker's Mills. |
| Barber & Robinson | Bolton Landing. |
| Bolton Landing Lumber Co | Bolton Landing. |
| Swan Bros | Chestertown. |
| Gifford Lumber Co | Glens Falls. |
| Kendrick & Brown Co | Glens Falls. |
| R. R. Norton | Glens Falls. |
| W. S. Worden | Lake George. |

VEHICLES AND VEHICLE PARTS.

| | |
|---|---|
| Barber & Robinson | Bolton Landing. |
| Joubert & White | Glens Falls. |
| George W. Buisch & Son | Lyons. |
| Philip Duechler & Sons | Lyons. |
| Lee L. Hall | Stony Creek. |

WOODENWARE AND NOVELTIES.

| | |
|---|---|
| Lee L. Hall | Stony Creek. |

MISCELLANEOUS.

| | |
|---|---|
| Glens Falls Match Co | Glens Falls. |

## WASHINGTON COUNTY.

AGRICULTURAL IMPLEMENTS.

| | |
|---|---|
| Cambridge Steel Plow Co | Cambridge. |
| W. Eddy Plow Co | Greenwich. |

BOAT AND SHIP BUILDING.

| | |
|---|---|
| John Ryan | Whitehall. |

BOXES AND CRATES, PACKING.

| | |
|---|---|
| Kenyon Lumber Co | Hudson Falls. |
| Myron G. Allen | Middle Granville. |

FIXTURES.

| | |
|---|---|
| J. B. Rice Seed Co | Cambridge. |

PLANING MILL PRODUCTS.

| | |
|---|---|
| White & Vogel | Comstock. |
| F. L. Crandall | Fort Ann. |
| Fred Potter | Granville. |
| Griffin Lumber Co | Hudson Falls. |
| Kenyon Lumber Co | Hudson Falls. |
| Frank Hollister | North Granville. |
| Charles Chamberlain | Salem. |
| J. S. Jenkins | Salem. |
| J. H. Fournier Planing Mill Co | Whitehall. |

**WASHINGTON COUNTY** — (Continued).

SASH, DOORS, BLINDS AND GENERAL MILL WORK.

Fred Potter .................................... Granville.
Griffin Lumber Co .................................... Hudson Falls.
W. J. Cruikshank .................................... Salem.
J. H. Fournier Planing Mill Co .................................... Whitehall.

WOODENWARE AND NOVELTIES.

Salem Mfg. Co .................................... Salem.

## WAYNE COUNTY.

AGRICULTURAL IMPLEMENTS.

A. A. Clark & Sons .................................... Marion.
C. A. Lind & Son .................................... Marion.

BASKETS AND FRUIT PACKAGES.

S. R. Der Dow .................................... Ontario.
H. S. Bradley & Co .................................... Sodus.
Chester Conant .................................... Sodus.
The Hibbard Basket Works .................................... South Butler.
George J. Druschel .................................... West Walworth.

BOATS AND SHIPS.

L. S. Lacey .................................... Sodus Center.
F. A. McMillian & Co .................................... Sodus Point.

BOXES AND CRATES.

George W. Buisch & Son .................................... Lyons.
S. N. Keener Co .................................... Newark.
Frank Clevenger .................................... Ontario.
R. J. Eaton .................................... Ontario.
The Gerlock Packing Co .................................... Palmyra.

BRUSHES AND BROOMS.

Barton & Keenan .................................... Hague.

CIGAR BOXES.

W. F. Classen .................................... Lyons.

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T. R. Webber.................................. New Rochelle.
N. Y. A. C., Yachting Dept., Travers Island........ Pelham Manor.
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## WESTCHESTER COUNTY — (Continued).

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## WESTCHESTER COUNTY — (Continued).

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| Garland Refrigerator Co. | Mt. Vernon. |
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| Kelsey, Smith & Co. | White Plains. |
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| | |
|---|---|
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|---|---|
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### PLANING MILL PRODUCTS.

| | |
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### SASH, DOORS, BLINDS AND GENERAL MILL WORK.

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### VEHICLES.

| | |
|---|---|
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| Barden & Robson | Penn Yan. |

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TECHNICAL PUBLICATION NO. 8

OF

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AT

SYRACUSE UNIVERSITY

HUGH P. BAKER, Dean

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BY

ARTHUR S. RHOADS

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## PREFACE

The chemical changes which occur in wood as the result of fungal activity are very imperfectly understood. The records of nearly all the work that has been done are in German and many of them are practically inaccessible. The present publication is an attempt to throw some light upon the nature and significance of so-called "Black Lines" or zones of decay which accompany the activity of several species of fungi in many kinds of wood. In this attempt use is made of all available published work, which is analyzed and discussed in the light of the observations and experiments which the author himself has made. It is not claimed that the problem is solved but this publication gives some new light upon the subject and opens the way for continued investigation of this important question. Further investigations upon this and other problems of timber decay are now under way in our laboratories.

L. H. PENNINGTON.

# THE BLACK ZONES FORMED BY WOOD-DESTROYING FUNGI.

ARTHUR S. RHOADS.

## INTRODUCTION.

Various phases of pathological study have occupied the attention of botanists at different times. Before the causes of diseases in plants where known the general external appearance of the affected organ was described. Later most of the attention was directed toward the discovery of the parasitic organisms which cause the derangements, and incidentally the study of the physiologic responses of the host plant was begun. Within the last few years many students of the subject have examined various morphological changes which occur in diseased plants, first dealing almost entirely with the gross anatomic appearance, but later making more minute histological and cytological investigations. Woody tissue when invaded by fungi, however, is just beginning to be studied carefully. Moreover, comparative studies are always helpful in deciding general principles. Only as we become acquainted with many examples of cytological and histological changes can we arrive at the truth regarding the reaction of the host plant to parasitic invasion. The practical value of such results can hardly be doubted.

To combat a disease successfully we should know as much as possible about the causes. We should therefore understand the pathologic reactions of the diseased plant. The relations between parasitic fungi and their host plants are of various kinds. Here we largely confine our attention to the effects of the fungus upon its host and, among these, we are principally concerned with those changes which disturb the normal physiologic processes.

For several years the black zones found in decaying wood have been a subject of much conjecture. Briefly stated, the problem resolves itself to this. In the early stages of the decay of dicotyledonous woods by many of the higher fungi known as "polypores," characteristic blackish zones, limiting various stages of the decay, occur as prominent features of the decomposition. These zones may extend in any direction through the wood or bark, their courses being determined by the initial starting point of the fungus and its subsequent growth and advancement through the wood. Their occurrence may be observed best on the cross sections of a tree or log which is but partially decayed. Here they usually appear as blackish or brownish-black lines of varying thickness (Plate 1). Strictly speaking, the term "line" should not be applied to these formations unless used in describing their appearance on a section of wood, since it is only when seen in this manner that they appear as lines. In reality they are thin zones of discolored wood which at first sharply separate the various stages of decay in the wood (Plate 1). If, however, the decay starts from several centers, so that the decayed areas overlap, the figure becomes complicated and the dark zones extend very irregularly throughout the whole mass (Plate 2). The course of the discolored zones of wood is in no way influenced by the course of the growth rings. It usually runs parallel to the direction of the woody elements, although there is considerable variation in this respect.

Microscopic examination shows these discolored zones to be caused by brown infiltrations in the cell walls and lumina of the cells. These infiltrations frequently become so abundant that they exude into the lumina of the cells, particularly the vessels, and occlude these completely (Plate 4, Fig. 1). This brown substance usually forms a blackish zone or layer but frequently appears merely as a brown discoloration in the wood. When seen in mass it is responsible for the dark coloration mentioned above. At the start the coloring material is a liquid but later dries to a brown amorphous substance. It is presumed that this brown substance consists of decomposition products that have infiltrated into the wood immediately in advance of the encroaching mycelium of the fungus.

In addition to the decomposition products associated with the activities of wood-destroying fungi, the formation of a similar substance has been observed to take place in the tissues of dicotyledonous trees exposed through wounds and as yet free from fungal attack. More recently attention has been called to the formation of similar substances in dead branches and fallen woody parts of dicotyledonous trees, even before they become attacked by wood-destroying fungi. In such trees, sections made through the wounds a few days after their formation show that brownish globules of a gum-like substance occur abundantly in the vicinity of the wounded area. These globules, commonly termed "wound gum" by the earlier writers, eventually flow together into larger ones which fill up the lumina of the woody elements, particularly the vessels, thereby protecting them to a certain extent against injurious influences. This protective effect, however, is not sufficient for absolute security against the decomposition and decay of the exposed wood. On this account wound diseases are much more likely to occur in dicotyledonous trees than in the conifers, for the resin secreted by the latter quickly flows out over the surface of the wound and excludes the entrance of air and fungi.

So far as the writer has been able to ascertain, this problem never has been made the subject of an investigation by anyone in this country. The presence of this discoloration is noted invariably in the majority of our descriptions of the decay of dicotyledonous woods. Beyond merely noting the occurrence of these zones of infiltrated wood, but little has been done toward the study of them. Occasionally they have been alluded to in slightly greater detail by a few authors in this country. On the other hand many valuable investigations carried on during the last quarter century by German workers, to explain closely related subjects, have thrown considerable light upon our problem. For the establishment of many important principles I am indebted to the writings of Dr. Ernst Münch which have been used as a basis for a portion of this paper, since the writer firmly believes that his explanation of the origin of this infiltration and its physiologic significance is the ultimate one. For this reason, and in order that the results of his investigations may be brought to the attention of those in this country who may be interested in them, a number of his results and experiments that deal with our question have been quoted.[1]

## HISTORICAL.

It is first necessary to review briefly the older literature dealing with the pathologic changes which, originating in the region of wounds in wood, are accompanied by a brown discoloration and are termed, according to their position and arrangement in the stem, "protection wood," "protection heart," "false heart," "pathologic heart," and etc. Frank (1895, p. 31)[2] states that the woody plants, without exception, exhibit the phenomenon of a darkening to a considerable

[1] This study was started in the Botanical Laboratory of The Pennsylvania State College under the direction of Prof. C. R. Orton, to whom the writer is indebted for advice and through whom he became interested in the problem. Grateful acknowledgment is hereby made of my indebtedness to Dr. William Frear and Dr. Guy Given of the Experiment Station for their instruction and advice upon the chemistry of the problem. Further investigation was carried on in the Botanical Laboratory of The New York State College of Forestry. The writer also wishes to express his gratitude to Dr. L. H. Pennington and Dr. H. P. Brown for many helpful suggestions and criticisms, both of the work and the manuscript.

[2] Bibliographic citations in parentheses refer to "Literature Cited," pp. 46-49.

depth of the tissue exposed through wounds. In cross sections of such wounds this is especially noticeable in as much as the discolored tissue is sharply differentiated from the underlying unchanged woody tissue. Microscopic examination shows that this darkening is due to the fact that the cell walls of the wood in question have been discolored by a brownish substance. Especially have the lumina of the vessels and the adjoining cells become filled up with a solid mass of brown material. Frank has named this brown material "wound-gum."[3] In the tissues thus modified, in the vicinity of wounds tyloses arise in most dicotyledonous woods. These are bladder-like outgrowths of the parenchyma cells which project into the vessels and occlude them quite effectually. We find the vessels partly filled with "wound-gum" and partly filled with tyloses.

Robert Hartig (1878), in his work on the diseases of wood, explained this browning as the first step in the decomposition of the wood or of wound decay. He stated (pages 66 and 140) that the dark brown discoloration of the decayed wood is due to the fact that a yellow or brownish liquid is contained within the woody elements. This liquid substance, upon drying, collects as a crust upon the cell walls or as a brittle yellow or brownish substance which cracks in various directions and completely fills the cells. He considered this substance to be a humus solution and stated that it consists of the decomposition products of the cell contents which have been dissolved in the water that leaches in from without and penetrates farther into the wood.

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[3] This substance has no connection with the true gum which arises through the secretion of the cell walls of stone fruits and tropical gum trees and which, in every respect, is of a different nature. Similar material has been called "protection gum" and "wood gum" by other authors. Theodor Hartig and certain later authors have used the word "Kernstoffe" which the writer has translated to the term "decomposition products" and used throughout this paper to avoid ambiguity and for the sake of uniformity.

In opposition to R. Hartig's conception, Frank (1884) stated that these brown masses of wound-gum in the darkened areas — likewise the tyloses — are products of living wood parenchyma. He reasoned that their formation is due to a universal life process to afford protection by excluding outside air from the living wood so that the natural functions of the latter are thereby kept undisturbed. He therefore called the wood thus darkened "protection wood." Frank stated further that its formation can be induced artificially by wounding and that one can cause it to be produced at any desired position in a living tree. According to Frank the protection wood is anatomically and physiologically identical to the heartwood which is to be found in most dicotyledonous trees after a certain age. The benefit which the tree receives through the closing of its woody elements to the outer air by the "protection wood" lies, according to Frank, mainly in the fact that the air within the wood becomes independent of atmospheric pressure.

Temme (1885), working under Frank's direction, found an increase in the specific gravity of the "protection wood" over that of the sapwood. He stated that the penetration of air and rain water through open vessels hastens the disintegration of the wood and also maintained that the wood browned by the infiltration of decomposition products offers a certain protection against destruction. From his experience in the care of trees, Temme concluded that the customary covering of the smaller wounds with tar or tree wax was superfluous, since they are closed temporarily by the protective wood until they are healed over, after which they are closed permanently.

It must be emphasized, however, that considerable credit is due to Böhm (1879) who had disclosed all of the essential features of protection wood several years before. He observed (p. 224) that the pathological transformation to heartwood occurs predominatingly at the boundary between living and dead wood. Even before Böhm, Theodor Hartig (1857) and others had concerned themselves with the most important phenomena of normal and pathologic heartwood formation as well as the chemical reactions of the infiltrating decomposition products.

Gaunersdorfer (1882) likewise contributed to this subject. He studied (principally on *Syringa*) a brown zone of protection wood in wounded twigs, established its similarity to normal heartwood, and made a careful examination of the brown infiltration. His results indicate a noticeable increase in weight for the pathologic heartwood. The physiologic significance of the protection wood is to retard or render impossible the harmful atmospheric inflow into the deeper-lying living tissue. It would seem, therefore, that the protection wood has an important function to fulfill. He assumed that the infiltrating substance is produced from living cells, chiefly from the starch grains. He, as well as Böhm, believed that the occlusion of wounds by the infiltration of the wood constitutes a safeguard against injurious external atmospheric influences.

Opposed to this von Tubeuf (1886) found in *Cytisus* that wood transformed to pathologic heartwood is easily penetrated and destroyed by fungal threads. Therefore he contested the idea that a protection is instituted against destruction and stated that the transformation of the margin of the wound to pathologic heartwood did not render the artificial closing of the wound unnecessary as had been claimed by the earlier authors. For the remainder von Tubeuf leaned toward Böhm's theory. In his opinion pathologic heartwood formation, subsequent to wounding, is a reaction against oxidation and pressure changes and, in specific cases, perhaps against fungal ferments. He confirmed R. Hartig's observation that all pathologic heartwood cells are dead.[4]

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[4] Further literature, the discussion of which would take too long, is given by von Tubeuf (1899).

The subject of pathologic heartwood formation received additional light through the investigation of the false heart of red beech by Hartig and Weber (1888). Normally the red beech does not form heartwood, even in old age. In many cases, however, brown discolorations start from branch wounds and spread through the interior of the trunk, often extending throughout its whole length. In this reddish-brown heart the vessels are occluded by tyloses and there are drops of gum in the parenchyma cells and other elements. It is stated that the increased entrance of air through the branch wounds permits an increased activity of the living parenchyma cells. This is shown by the formation of tyloses and wound gum in the parenchyma cells. It was observed that fungal mycelium also occurs frequently in the dark brown heart. The false heart is to be considered as pathologic and does not differ essentially from genuine heartwood.

Hermann (1902) confirmed the opinion of R. Hartig on the origin of the false heartwood from branch wounds. He also found fungal mycelium present in nearly all cases. The false heartwood was considered as a protection by the tree against the entrance of wood-destroying fungi into the wounds. The fungal hyphae are at first occluded from air and moisture by the tyloses and masses of gum, and their development retarded. The tyloses and gum formations ultimately are dissolved by the penetrating fungal hypae.

Tuzson (1903) arrived at similar conclusions. He stated that the tyloses and wound gum occur in the heartwood merely in consequence of the stimulation by the fungus and not as a reaction against the entrance of air after wounding. He found that the red heartwood is more resistant to fungi than the sapwood. The observation that a similar formation of false heartwood also occurs in felled wood attacked by fungi is important. Tuzson found that the formation of false heart increases the specific gravity of the wood.

Some work of Lindroth (1904), which is also based upon the protection wood theory, is of more importance. Lindroth investigated the pathologic heartwood (the protection wood of Frank) found in a thin zone surrounding portions of wood decomposed by *Polyporus nigricans* Fries. Such pathologic heartwood proved to be rich in infiltration products and thereby increased in weight, hardness, and durability. He stated that this infiltrating substance arises through the combined action of the fungus in the rotten heartwood, and the oxygen of the air. The pathologic heartwood was considered by him to retard the progress of the fungal decomposition.

To sum up these rather diversified results of the earlier workers, the brown substance commonly occurring in the vicinity of wounds in wood is to be considered as a secretion of the parenchyma cells. This substance is said to have the function, either in conjunction with the tyloses or in their absence, of occluding the severed vessels. By this means the air in the tissues is rendered independent of the atmospheric pressure. In this manner the tissues are protected against the entrance of fungi and consequent decay. The cells are stimulated to form tyloses and decomposition products by means of fungal hyphae, wound stimulus, entrance of oxygen, and pressure changes. The discolored wood is denoted, according to its position in the stem, as protection wood, false (pathologic) heart, or protection heart (when surrounding wounded areas). It is said to be similar to normal heartwood.

Münch (1910[2]) arrived at somewhat different results by which he very clearly settled the differences of opinion existing among the earlier authors. His results concern, first of all, the origin of the brown substance, the decomposition products, arising in the protection wood. He states that this substance is not a secretion of living cells but that it arises only after the death of the cells as an oxidation product of the cell contents.

Münch states that when tyloses occur in pathologic heartwood along with the decomposition products they have an entirely different method of formation and cause than do the decomposition products. It is his belief that they arise earlier while the woody elements are still alive, as outgrowths of the same. He attributes their formation to the entrance of air through a wound, that is, to wound stimulus.[5] Moreover, these stimuli result in an increased transportation of nourishment into the living tissues surrounding the dead (infiltrated) portions of wood. If these enriched portions of the wood are killed afterwards and infiltrated, the false heart thus produced has (according to Münch) an appreciably higher specific gravity than normal wood. The occlusion of the vessels retards the ready access of external air. Therefore the paucity of oxygen within the tissues of living wood renders it less penetrable to fungal hyphae.

## ORIGIN OF THE DECOMPOSITION PRODUCTS (KERNSTOFFE).

The earlier authors did not agree as to whether the decomposition products (wound or protection gum) arise as a secretion product of living cells or as an oxidation product of the dead cells. Frank's statement that the cells furnishing the decomposition products are living during the formation of such substances never has been proved and it must suffice to consider his theory as wholly hypothetical. Even Frank's work does not appear to justify this statement and it appears from it and still more from similar investigations by Will (1899) that the formation of decomposition products cannot be the result of a vital process. Frank (1884, p. 323) described the microscopic details of wound gum formation

[5] According to Münch (1910[2]) tyloses also occur at points where the entrance of air is excluded and the stimulus afforded by fungous excretions or decomposition products must be accepted as the reason for their origin.

as follows. In the vicinity of the margins of wounds a reddish discoloration was observed after 8 to 10 days. This is due to a coloration of the cell walls, especially those of the pith rays. In these cells brown drops (the wound gum) arise as a new formation of the cell contents and partly as a transformation of the starch grains. Their formation then continues farther. The brown substance infiltrates the cell walls and eventually exudes into the lumina of the vessels, partly occluding them. From this description it does not appear that Frank's view is justified for, as Münch (1910[2]) has stated, a "browned" tissue, the parenchyma cells of which are filled with brown material, is necessarily dead and therefore incapable of further vital activity. In such tissue described by Frank, if the formation of the brown substance continues, then it can hardly be a question of a secretion of living cells.

It is difficult to understand how anyone can consider such changed and discolored cells to be alive. The investigations of Böhm, R. Hartig, von Tubeuf, and later those of Münch (1910[2]) have shown, beyond all possible doubt, that the cells furnishing the decomposition products are always dead. Münch found that the formation of the brown product occurred in dessicated cells as well as those infected by fungal hyphae — cells which were unquestionably dead.

There is no further foundation for asserting that the decomposition products arise from living parenchyma cells other than the following account of Frank (1884, p. 330) in which he states that the gum formation as well as the formation of tyloses is truly a vital process and not a purely chemical process of disintegration. This follows from the fact that it does not occur in fallen trees and branches as soon as they are dead. Münch (1910[2]) declares this to be wrong and states that under certain circumstances there arises in fallen, doubtlessly dead, woody parts a brown material which, according to its appearance, origin, and chemical reactions, may be designated as Frank's wound gum. In order to prove this he made detailed studies of poplar (*Populus balsamea*) twigs, in which he allowed unpeeled twigs to dry out in a room so that generally from one to two weeks elapsed before they showed signs of dessication. He observed that death naturally took place first in the vicinity of the cut ends and that the bark and outermost portions of wood likewise died before the deeper-lying ones, which were better protected from drying. The protoplasm became rigid and lost its fine granular structure; in addition the most of it turned a light brown. In the twigs, soon after the death of the parenchyma cells, there occurred a darkening of the wood and especially of the bark. Münch furthermore determined that the dark color originated exclusively from the brown substance which was present in the parenchyma cells and that the darkening appeared first in the parts which were more affected by the drying, that is, at the ends and at the periphery. Thence it proceeded rapidly toward the center of the twig.

Upon making radial sections at the place where only the outer part of the wood was darkened and the inner was still white, Münch observed that the pith ray cells at the boundary between these two areas contained several brown globules. He found that all the cells, even the inner ones which were still uncolored, had died and did not respond to the plasmolysis test. Farther toward the outside scattered brown droplets were noticed in the vacuoles of the protoplasm. In the cells situated near the periphery of the twig these brown droplets had coalesced to form larger drops. These frequently contained several small bubbles. Münch states that examination of such cells showed unmistakably that the liquid contents of the vacuoles suddenly become changed at some time after the death of the cells to brown viscid drops which became firm and hard after coalescing. In wood that was still further dried he observed cracks in some of the individual brown globules.

These brown globules, according to the illustration and description given by Münch are identical in appearance and chemical properties with those observed by the writer in the sapwood of a log of pignut hickory, *Hicoria glabra* (Mill.) Britton, attacked by a common sap-rot fungus, *Coriolus prolificans* (Fries) Murrill. Radial sections (10 microns) were made of portions of wood which were in the first stage of decay — that is, the wood had been penetrated by fungal hyphae but disintegration had not started. The portions which were sectioned consisted of small resistant areas of wood (Plate 3) left intact after the remainder of the sapwood of the log was completely decomposed. These areas were sharply demarked from the surrounding, almost completely decayed wood by prominent black zones. In these radial sections almost all of the pith rays contained abundant brown droplets (Plate 4, Fig. 2).

According to Münch the brown substance in the pith ray cells of the poplar twigs examined by him is identical with that spoken of by Frank (1884) as wound gum and by Th. Hartig (1857) as "Kernstoffe," since it possesses all of the characteristic chemical properties mentioned by Th. Hartig and Frank and has a similar origin. Münch finds it to be insoluble and to remain unchanged in water, alcohol, ether, concentrated caustic potash, concentrated sulphuric acid (in which the wood swelled up and became darker), and cold concentrated nitric acid. In boiling concentrated nitric acid he observed that the brown substance quickly dissolved to a colored solution. The latter reaction had been reported earlier by Th. Hartig (l. c.), who had first studied the substance.

Frank (1884, p. 324) in describing the characteristics of wound gum states that if a cross section of such infiltrated wood be digested for a quarter of an hour with dilute hydrochloric acid and potassium chlorate the gummy substance is converted into a new compound which, while likewise insoluble in water, is readily soluble in alcohol. Continued digestion with this reagent, however, finally dissolves the gummy substance completely. Münch found that this reaction took place in the substance with which he worked, especially when the mixture was hot; with a cold mixture, as a rule, a greater time was required.

Münch ($1910^2$), however, considers it an error of Frank, which had not been disputed previously, that this reaction (alcohol solubility after digestion with hydrochloric acid and potassium chlorate) is a particular characteristic for wound gum. He is of the opinion that the same reaction probably also occurs with starch-containing cells which do not show the slightest trace of browning or gum formation. As proof of this Münch treated thin sections of the inner, absolutely white, living sapwood of *Prunus avium* and *Fagus sylvatica* for ten minutes in the above-mentioned mixture. After this treatment the rich starch contents changed into clear drops which, upon the addition of alcohol, disappeared instantly under the microscope. He found that the same behavior was exhibited by the contents of the bark cells regardless of whether they were living and colorless or dead, browned, and filled with the brown substance. From the action of such strong reagents, however, he failed to draw any conclusions as to the nature of the substance.

According to Münch ($1910^2$), the brown congealed product of the cell contents arises not only in cells killed by dessication but likewise in cells killed by other causes. The recognized browning caused by fungal attacks originates generally from such substances only, in this case, they are less isolated and in general occur mixed with the cell contents (remnants of the protoplasm). Moreover, they are present here mostly in slight quantity because the constructive product, the cell contents material, has already been partially consumed by the fungus. In order to prove this Münch examined poplar twigs which he infected while living with *Stereum pur-*

*pureum.* In these he found, in the vicinity of the hyphae growing nearest the vessels, that the protoplasm of the parenchyma cells was dead or nearly so. It had contracted from the cell walls and gave slight or no further plasmolysis with suitable reagents. The remaining cell contents had collected as colorless drops which were soon browned and mixed with the dead protoplasm so that the pith rays *en masse* appeared brown. Even here the brown substance gave all the reactions recorded for wound gum except that the resistance against the use of cold hydrochloric acid and potassium chlorate was many times greater than that given by Frank. Münch was convinced that even in this case — of death through fungi — the brown substance arises only after the death of the cells but never, however, in living tissues. He observed this clearly by microscopic examination of infected living twigs and pieces of wood, especially in those cases in which he permitted fungal hyphae to grow over the surface of living wood in a moist chamber. In this case he could easily follow the advance of the fungus and the browning. It was evident to him that the latter does not precede the fungous attack but appears only at some distance behind the growing, pointed hyphae where the sound wood cells had been killed by the fungus.[6] He concluded that the browning therefore can not be a preventive measure, a means of protection of the plant against fungous attack.

According to Münch (1910²) the substances which furnish the decomposition products may leave the cells, after the death of the protoplasm, and exude into the lumina of the vessels. For this, however, a greater quantity of cell sap is required than is at the disposal of the drying poplar twigs. He believes that the oxidation of these products occurs mostly in the vessels which are rich in oxygen. The oxidation of

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[6] According to Münch it is different in living trees where the fungal ferments become distributed by the sap-flow and can then act injuriously upon distant-lying cells.

these products results in the formation of the brown drops which later become solidified and occlude the vessels. Moreover, in coniferous woods which are killed by fungi the brown drops occurring in the parenchyma cells are, to all appearances, of the same nature and manner of origin.

With regard to the transformation of the cell contents of coniferous woods, Münch cites an experiment by which he could follow, microscopically, the entrance of a bluing fungus, *Endoconidiophora coerulescens,* into the parenchyma cells of pine wood. He made thin radial sections from living pine wood and placed them in hanging drops in van Tieghem cells, the whole being done under sterile conditions. In the case cited the reserve material consisted entirely of fat in the form of a fine emulsion in the protoplasm. If no infection followed he noted that such cells in a hanging drop culture remained unchanged for several days. If, on the contrary, viable fungous spores were inoculated into the drop culture he observed that the conditions changed at once. As soon as the fungal hyphae reached a pith ray they promptly invaded it, ramified, and soon filled the cells completely. He observed that the fine granular structure of the protoplasm immediately disappeared into the cells attacked and the contents flowed together into drops. Upon careful observation, minute thin-walled fungal hyphae were always to be found in the cells thus altered. These drops were still colorless at the end of the experiment and were (as Münch learned by comparison of other tests of wood killed by such fungi) similar in every way to those previously described by Frank except that they did not become brown. That this substance can also occur in the parenchyma cells of coniferous wood had been found previously by Will (1899).

The writer has never observed nor could any reference in literature be found concerning the occurrence in coniferous woods attacked by wood-destroying fungi, of the prominent blackish zones which are characteristic features associated with certain decays of dicotyledonous woods. Similar formations are characteristic of the decay of spruce and larch caused by *Porodaedalea pini* (Thore) Murrill, but they are inconspicuous when compared to the broad zones of decomposition products which commonly occur in the decay of dicotyledonous woods. Such decomposition products arising through the decay of coniferous woods by wood-destroying fungi apparently are small in quantity compared with those arising through the decay of dicotyledonous woods. Why we have such a condition is not known.

If the decomposition products in question were dependent upon the hemicellulose, xylan (wood gum), for their source we might have a plausible explanation of this peculiar circumstance. According to Storer (1898) the evidence thus far accumulated tends to show that the wood gum in the trunks of trees is, comparatively speaking, difficult of digestion and less active, physiologically speaking, than the true cellulose with which it is accompanied and combined. In proof of the small quantity of wood gum obtainable from coniferous wood by the direct action of alkaline solutions, Thomsen (1879, p. 159) says that, unlike the wood of dicotyledonous trees which give up to dilute soda lye from 8 to 26 per cent of wood gum, fir wood is hardly at all acted upon by soda lye. He obtained less than 0.8 per cent of wood gum from spruce wood and less than 0.5 per cent from fir wood. In these coniferous woods he states that wood gum appears to be present only in minute quantities. Other authors have come to similar conclusions in regard to the wood gum content of other coniferous woods.

The great differences in structure between coniferous and dicotyledonous woods suggests another plausible reason for the discrepancy between the relative amounts of decomposition products arising through the decay of these respective classes of woods. In the dicotyledonous woods, owing to the presence of much larger elements — the vessels — we should naturally expect to have an increased flow of air through the wood, thereby permitting a much more rapid and complete decomposition than could possibly occur in coniferous woods.

In order to be entirely certain that the decomposition product is produced in cells that are attacked by wood-destroying fungi, Münch conducted an experiment in which he placed pieces of fresh beech sapwood in closed sterilized chambers and observed them for several weeks. He noticed that these wood samples developed tyloses profusely; in the cambium region even a luxuriant growth of callus began. However, the familiar brown coloration betraying the formation of the decomposition products did not appear, the surface of the wood merely coloring to a pale yellowish brown. If, on the contrary, the pieces of wood were inoculated with a wood-destroying fungus the discoloration, indicative of the decomposition of the cell contents into a brown substance, arose immediately in all parts killed by the fungus. There can therefore be no doubt that the brown drops, designated by Frank as wound gum, are a decomposition product of the cell contents and that they occur only in dead cells.

The striking fact that the cell contents, which are without question very easily oxidized, do not experience oxidation in the cells even where there is a free transmission of air through the wood is to be explained by the properties of the living protoplasm. With the death of the protoplasm by drying, frost, heat, fungous attack, etc., its permeability is destroyed. As a result the air flows in upon the vacuole contents which are no longer protected and oxidation of the cell contents occurs.

The presence of moisture is as necessary to the oxidation described as it is for most chemical decompositions of that nature. According to Münch, in the case of the poplar twigs for example, if the dessication be greatly hastened by removing the bark and drying in a hot room, no browning occurs. In this case, after the death of the protoplasm by dessication, he believes that the twigs lose their moisture too rapidly for the browning to follow. It is also known in other cases that rapid removal of water prevents browning. The prompt drying of pressed plants obviates the dark coloration; fruit dried quickly retains its bright color. Münch (1910[2]) has stated to the contrary, however, that in many kinds of wood (beech, etc.) no browning occurs even when the drying is gradual. On the other hand he finds that the browning does not occur if the necessary degree of moisture but insufficient oxygen is present. According to the same authority, wood that is very rich in water and therefore poor in oxygen remains uncolored for a long time. The fact follows that the absence of browning is no proof of freedom from fungous attack.

Bailey (1910) investigated the discoloration of sapwood, or "sap-stain" as it is called commonly, which occurs on freshly cut surfaces of certain dicotyledonous woods. He found that when freshly cut surfaces of such woods were exposed to the air under favorable conditions of temperature and moisture a chemical reaction started which, with varying rapidity, produced a colored substance in the wood. The examination of microscopic sections of this sap-stained lumber revealed the fact that the colored substance produced by the chemical reaction was most conspicuously developed in the pith rays and wood parenchyma cells, living tissues which are largely concerned in the storage and conduction of food in the wood. Bailey points out further that in general sap-stain is the result of two agencies: the attacks of fungi and chemical discoloration, the latter being caused in the sapwood by the activity of oxidizing enzymes. That both agencies are closely related to the food substances available in the wood is shown by the fact that the discoloration, whether produced by the activity of fungi or by chemical reaction, is most conspicuously developed in the pith rays and wood parenchyma cells. In addition both agencies producing sap-stain are dependent upon atmospheric oxygen, heat, and water in certain proportions. According to Bailey the optimum conditions for sap-staining are found in green timber during hot humid weather, whereas unfavorable conditions are found in cold dry weather and in logs immersed in water.

It is generally known that if fungous-infected wood be exposed to the air for several hours its surfaces turn brown. This is especially striking in woods that normally are white. Lindroth (1904) has made observations of this nature on sections of birch wood decayed by *Polyporus nigricans* Fries. He marked the outer limit of a dark zone on a section with a lead pencil and after keeping the wood in a moist chamber for 15 hours observed that a new discolored zone had formed outside of the pencil mark. He concluded therefore that the formation of this new discolored zone occurred through the combined action of the atmospheric oxygen and the fungus. That the oxygen alone did not cause this is obvious because sound birch wood does not become colored so rapidly when exposed to the air under the above conditions. That, on the other hand, the fungus alone did not cause the new discoloration he confirmed since the dark zone could only be found within a few millimeters of the exposed surface.

As Münch (1910[2]) correctly stated, the formation of the brown decomposition product is dependent upon the concurrence of three factors, the presence of dead cells, an optimum supply of moisture, and a sufficient supply of oxygen to promote oxidation. This makes it clear why the so-called protection wood formation is often confined to a very definite zone, namely directly at the boundary between dead and living wood.[7] In Münch's opinion it would be far more con-

[7] In addition to the above-described formation of the decomposition products resulting from the oxidation of the cell contents Münch (1910[2]) observed that the mycelium of certain fungi excreted drops of a substance which, upon microscopic examination and microchemical tests, apparently was identical with that arising in the parenchyma cells of

ceivable that similar brown oxidation products may be formed from substances which occur in the free cell sap. In some instances, however, as in cherry wood, the large amount of substance infiltrated in the vessels cannot be attributed to the contents of the parenchyma cells but must come from some other source — possibly the cell wall.

Modern researches have shown that a number of hemicelluloses occur as carbohydrate reserve materials which are deposited in the form of thickened cell-walls in the endosperm of seeds and as secondary layers of thickening in the wood parenchyma and wood prosenchyma elements of certain woods. By means of enzymes these reserve materials may be converted into gums and sugars, in which form they may be transported to those parts where growth is taking place. The investigations of Grüss (1896) have shown that a cell-wall which consists of a mixture of two hemicelluloses, is dissolved fractionally by the action of a cytolytic enzyme, that is, one constituent earlier than the other. He found further that the hemicelluloses araban and galactan were transformed respectively into the gums arabin and galactin which could be transported to tissues even before they were further changed into the sugars, arabinose and galactose. Grüss finds that these gums occur in the dormant reserve materials of the genera *Acacia, Astragalus, Prunus,* and others, and denotes them as reserve gums. He finds that the result of oxidizing enzymes on the hemicelluloses is to effect a partial digestion of this assimilation product, by which sugar and gum is formed, the amount of gum varying with the completeness of the digestion. After the resolution of the hemicelluloses into sugar and gum the sugar is leached out while the gum is left behind. Grüss is of the opinion that this

wood as an oxidation product of their cell contents. He states further that, while possible, it is extremely improbable that substances similar to oxidation products of the cell contents may be excreted by fungi in certain woods.

enzymatic digestion of the hemicellulose reserve materials is the explanation for the phenomenon of gummosis.

As was stated earlier, the hemicellulose, xylan, is difficult of digestion and less active physiologically than the true cellulose with which it is accompanied and combined. After this hemicellulose is converted into sugar and gum by enzymatic action, it is not impossible that the gum may be further changed by an oxidative or other action into an insoluble by-product while the sugar is utilized as food by the fungal hyphae.

## RELATION OF PATHOLOGIC AND NORMAL HEARTWOOD.

All who have concerned themselves with the question of the relation of pathologic and normal heartwood have considered them from the anatomic and physiologic standpoints. In normal heartwood formation it is to be supposed that the inner, older parenchyma cells have died normally through age, lack of function, deficient food supply, etc., and that their contents, in part at least, seep through the cell walls and even ooze out into the lumina of the neighboring cells. The normal heartwood is also to be regarded as an initial stage of decomposition when considered in this limited sense. Where tyloses occur they may be considered to have arisen from the parenchyma cells which remain alive longer than the other elements. The older sapwood is always poorer in water and richer in air than that last formed. It has been found that heartwood, normal as well as pathologic, has greater specific gravity and is richer in solid substances than the sapwood. The transformation to heartwood therefore must be regarded as an addition to the woody substance due to the oxidation of the cell contents and the decomposition of these residues within the woody elements.

It must be remembered that, in the case of pathologic heartwood near wounds in living trees, an increase in weight has been established only for those portions transformed to heart which lie on the outer surface of the wounded tissue. Here the tyloses and infiltrated decomposition products are most abundant, often in such quantity that an increase in material is evident by mere macroscopic observation. These parts are easily recognized macroscopically by their darker color. They either surround, as " protection heartwood," portions of wood less strongly transformed to heartwood or they bound wound surfaces as " protection wood." In these cases this zone of " protection wood " is distinguished from the dead wood which it isolates, only by the fact that the tyloses and the oxidation products are more abundant. Hermann (1902) has already mentioned this as occurring in the pathologic heartwood of beech.

An explanation of this remarkable accumulation of brown material in the uninjured tissues directly underlying dead wood in wounded areas is furnished by the discovery of Münch (1910[1], p. 389). He has pointed out that wherever woody or bark tissues are killed there is an extraordinary movement of formative materials toward the neighborhood of the dead area as a result, so that in such places the cambial activity may be increased several times and additions to the bark may occur beyond the normal. According to the same author the living parenchyma cells in the neighborhood of dead cells have a special attractive force for the formative materials and consequently an increased growth and subdivision may occur, which often is manifested in a prolific formation of tyloses. So, for example, when the fungal hyphae penetrate and consequently kill a portion of the wood an abnormal stream of building materials then flow into the tissues adjoining the dead areas and the parenchyma cells involved develop tyloses. The parts previously rich in these substances are killed likewise by the advancing fungus and its diffusing enzymes. The cell contents are oxidized, after which the transformation to pathologic heartwood is complete.

As Münch (1910²) states, it is therefore clear that an important accumulation of materials occurs, especially in those places where the drying is gradual or where the penetration of the disease-producing organism is very slow as, for example, in the periphery of the decayed areas. Here the wood cells have the maximum time to attract material to them before they in turn become attacked and killed by the fungal secretions or other injurious influences. It is not impossible that even after death a woody portion may be enriched by the flow of substances from the surrounding, living cells due to purely physical causes and, upon the concentration of such substances the deposition of them as solid materials may occur within the areas concerned. Otherwise the frequently described accumulations of calcium carbonate and calcium oxalate in plant tissues would be difficult to explain. However, this is to be regarded as a hypothesis less well established.

Such increase of substance as a result of pathological heartwood formation has been investigated by numerous workers. Lindroth (1904) stated that the infiltrated decomposition products formed in birch wood, as a result of its decay by *Polyporus nigricans* Fries, imparts great hardness to the wood and retards the decomposition of the same. He stated that while the specific gravity of the sound wood was 0.99, that of the dark infiltrated zone was 1.23. By absolute dry weight he found the specific gravity of the sound wood was 0.77 while that of the dark zone was 0.90.

## THE PHYSIOLOGIC SIGNIFICANCE OF THE DECOMPOSITION PRODUCTS.

Many investigators have observed that the fungal hyphae do not appear to be able to penetrate the heavier infiltrations of decomposition products occurring as blackish zones demarking decayed from undecayed areas of wood. Consequently they have attributed a protective effect to this formation. Lindroth (1904) in discussing such a zone of "protection heart," as he called it, caused by *Polyporus nigricans* Fries in birch wood, states that it is especially resistant to decomposition and offers a certain protection against further attack by the fungus. If it should happen, as these blackish zones continue to become thicker, that the supply of water within the diseased portions of the wood falls below the demand made upon it by the fungus, the mycelium — providing it has not been smothered in the meantime — may break through and transform another zone into pathologic heartwood. This gives rise to the well-known concentric blackish zones which at first sharply separate the various stages of the decay in wood (Plate 1).

It is plausible that the occlusion of the vessels and other elements of the wood renders the pathologic heartwood, as well as the healthy wood lying directly without it, relatively free from air; furthermore it inhibits the circulation of air and hence the inroads of the fungal hyphae. It is also possible that the brown decomposition products with which the cell walls frequently are infiltrated may be, to a certain degree, harmful to fungi. At least such infiltrated substances are more difficult for them to assimilate than those constituents which have not yet been oxidized. Owing to this the contents of the cells which otherwise would be an important source of nitrogen for the growth of fungi have assumed through chemical decomposition a form more difficult to assimilate. On these grounds greater resistance to decomposition by fungi is to be expected, especially if the fungi which have caused this transformation to pathologic heartwood are already smothered. For fungi coming in later the culture medium is made poor.

Under optimum conditions for the growth of fungi, heartwood (normal as well as pathologic) in its typical condition is more highly resistant to decay than the sapwood. In a living tree, however, the sapwood frequently is less attacked than the heartwood, a condition often resulting in hollow trees. This condition generally occurs from the absence of oxygen in the sapwood in consequence of its large amount of water. As soon as the moisture ratio between the heartwood and the sapwood is upset, as in dead or felled wood, the sapwood which (owing to its greater abundance of food materials) is by far the more favorable medium for the growth of fungi and is decomposed much more quickly than the heartwood.[8] Von Schrenk (1900, p. 48) has observed the readiness with which the sporophores of many wood-destroying fungi can be induced to form wherever a wound is made in the diseased trunk, thus admitting air. As we now know, the decomposition of woody tissue occurs through the combined action of fungal hyphae (by virtue of their enzyme excretions), water, oxygen, and a favorable temperature. The entrance of air alone does not destroy the woody tissue and in the absence of sufficient air and moisture the fungal threads, which decompose the wood, cannot function.

Decomposition very seldom occurs from small surface wounds in trees or in the cut ends of small branches because here the injured woody portions are sufficiently protected by the absence of air in consequence of the large water content of the sapwood. The conditions are otherwise where the deeper-lying tissues of larger limbs or the trunk are exposed, since these are better aerated. In the latter case fungal hyphae penetrate, following the vessels and pith rays, and ramify in the center of the stem. The result is that tyloses are formed in the vicinity of the wounded areas where the wood is still living. Later, after the death of the parts attacked, the browning of the contents of the parenchyma cells (formation of decomposition products) occurs. As has been shown, both of these formations are to be seen most frequently in the regions immediately adjoining the infected areas,

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[8] Compare the investigations of Tuzson (1903, p. 16) and those of Münch (1910[2]) which agree in the essential points.

especially where the advance of the fungus is very slow or almost stopped. The portions of the wood thus changed have been designated as "false (pathologic) heart." Münch (1908, p. 44) is of the opinion that the small supply of air in the interior of the tree as a rule suffices only for a slight growth of the fungus. This causes merely a browning of the wood cells without affecting the woody substance to any great degree. If larger wound surfaces are left unprotected the air in the deeper-lying tissues is constantly renewed (Münch, 1908, p. 44). The fungus may then continue its existence and work of decay. Thus the "false heart" is transformed into heart-rot. The same author (1910[2]) states further that the renewing of the air by means of diffusion and diosmosis, which varies according to the greater or less porosity of the wood and from other reasons, plays an important role. From this it follows (according to Münch) that the oxygen streaming in from the outside in a radial direction toward the heart or in the intercellular spaces of the pith ray cells is respired by the living sapwood cells, either partially or entirely. Therefore it is merely the remainder of the oxygen left after respiration that is available for the fungus living in the heart. In his opinion more or less oxygen is admitted to the attacked heart, according to the intensity of the respiration, the number of wood cells, etc. Nothing more definite can be ascertained concerning this matter until our knowledge of the vitality of the wood cells is increased.[9]

It is appropriate that the question of what eventually becomes of the decomposition products as the decay progresses be discussed briefly at this point. The writer has observed frequently in the case of the decay of logs of pignut hickory, *Hicoria glabra* (Mill.) Britton, and other woods by *Coriolus prolificans* (Fries) Murrill, that the decomposition products

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[9] Compare the conclusions of Münch (1910[1]).

disappear with the completion of the decay. Von Schrenk (1914), in discussing the decay of lilac (*Syringa vulgaris* L.) stems by *Polystictus versicolor* (L.) Fries, says that the brown substance is destroyed ultimately when the decay nears completion. The decomposition products, which have been shown to originate with the advancement of the fungus through the sound wood, are likewise destroyed by the fungus upon the completion of the decay in a given area and no traces of them are left in the completely decomposed wood. Evidence of this is to be found in that the decomposition products at first are always present in a thin zone between the decayed and undecayed wood. Later when the decay spreads from several centers the decomposition products collect in thin zones between the various areas of wood in different stages of decay. Thus the constant association of these blackish zones of decomposition products with that portion of the sound wood bordering upon the decayed wood is to be explained by the fact that they are destroyed upon the completion of the decay within any one area but new ones constantly form from the sound wood as soon as it is attacked by the advancing fungus.

There remains to be considered the identity of those substances from which the decomposition products are formed, the chemical changes taking place, and the final chemical nature of the brown decomposition product. The present study has not been sufficiently extensive to answer these questions fully. Here we are entering a little known field since, even at the present time, but little has been achieved as to the chemical composition of sound wood and virtually nothing concerning the chemical changes which accompany its decay.

It is evident, however, that the cell contents and possibly certain other substances originally combined with cellulose and lignin to constitute the cell wall furnish the formative material which, through oxidation in the presence of moisture, coagulates to thick drops and gives rise to the decomposition products which ultimately infiltrate certain portions of the wood, giving rise to blackish zones.

## CHEMICAL NATURE OF THE DECOMPOSITION PRODUCTS.

The indefinite and complex group of substances formed by the partial decomposition of vegetable matter is generally called "humus" and so long as the word is used in a collective sense as a convenient term it may be retained. From its general properties we may infer that "humus" is a slowly oxidizable colloid varying in color from brown to black. Unfortunately we cannot get much farther at the present time. The partially decomposed material of woody plants forms a particularly vague and indefinite group of substances containing all the non-volatile products of fungal, enzymic, and oxidative reactions on the plant residues. A detailed study of this group being thus out of question we must first ascertain what part it bears to the original woody substance and then, when we know what to look for, try to discover what particular constituents of the woody plant enter into its formation.

These decomposition products which subsequently infiltrate certain portions of the wood are exceptionally resistant to chemical reagents. Heald (1906) in discussing the deposits of it in cottonwood due to *Elfvingia megaloma* (Lév.) Murrill, states that it is evidently insoluble in alcohol, ether, caustic soda, caustic potash, hydrochloric acid, and only slightly soluble in strong nitric acid.

Stevens (1910, p. 367) states that wound gum may be found lying free in the dead cytoplasm, surrounding starch grains which have contributed to the formation of the gum-like substance. He gives the properties of wound gum as follows: "Wound gum is not soluble in warm water, but may be dissolved in hot nitric acid or in eau de Javelle after several hours. It is not soluble in sulphuric acid, potassium hydrate, alcohol, or ether, but may be dissolved in alcohol after treatment for a few minutes with a solution of potassium chlorate in dilute hydrochloric acid. It may be stained with a solution of fuchsin, iodine green, safranin, or methyl green. It is stained red by phloroglucin and hydrochloric acid." The writer has observed that the previously described drops formed in hickory wood by *Coriolus prolificans* (Fries) Murrill, also may be stained by these respective reagents.

According to Temme (1885) wound gum agrees with many sorts of gums in that it yields oxalic and mucic acids on oxidation with nitric acid. It differs essentially, however, from all gums in not swelling in water and in being insoluble even in caustic potash and sulphuric acid. As has been recognized by Temme, wound gum is stained deep red by phloroglucin and hydrochloric acid. Molisch showed later (1888, p. 264) that it behaves just like lignified membranes in aniline sulphate, metadiamido-benzol, orcin and thymol; and he believes that wound gum contains vanillin in solution.

Tests upon radial section (10 microns) of the wood shown in Plate III, these sections being identical with those shown in Plate IV, Fig. 2, were made to determine the solubility of these decomposition products. The solubility tests were made by exposing thin sections to the action of the reagent (without heating) in watch glasses, meanwhile making observations with the microscope. If the numerous globules of the decomposition products, which are readily visible in the pith ray cells under the low power of the microscope, did not dissolve after a reasonable length of time a small quantity of the reagent and sections were transferred to a test tube, heated to the boiling point, and again examined under the microscope. The globules of decomposition products were found to be insoluble in water, concentrated ammonium hydroxide, 10 per cent solution of sodium hydroxide, 10 per cent solution of potassium hydroxide, and concentrated hydrochloric acid. In cold concentrated sulphuric acid the wood was carbonized but the globules remained intact. Upon heating the acid to boiling the wood dissolved together with more or less of the decomposition products. In cold concentrated nitric acid the decomposition products were insoluble but upon heating to boiling the wood dissolved together with the globules, forming a brown solution. Moreover, tests performed with other sections indicated that the decomposition products in question were insoluble in absolute alcohol, xylene, acetone, ether, petroleum ether, chloroform, carbon bisulphide, and carbon tetrachloride. In addition to this, sections of the wood containing the globules of decomposition products were placed in a concentrated solution of chloral hydrate and kept at a temperature of 55 degrees C. for one week. There was no effect other than a slight swelling of the globules. The same sections were then washed in water and dehydrated by alcohol. Part of them were treated with clove oil and the remainder with cedar oil, but the decomposition products remained insoluble in both cases.

An attempt was made to determine more fully the chemical nature of the decomposition products by means of a comparative analysis of sound and decayed wood. Sapwood of a log of pignut hickory, *Hicoria glabra* (Mill.) Britton, which was partially decayed by *Coriolus prolificans* (Fries) Murrill, was used in the study of the decayed wood and sapwood from a living tree of the same species (gathered in the spring) for the sound wood. In the case of the decayed wood a thick black layer of infiltrated wood sharply demarked the completely decayed wood from the small areas of sound wood remaining, these areas being only in the first stage of decomposition (Plate III). This black layer, as well as the wood enclosed by it, was very hard. The infiltrated wood was shaved off carefully, care being taken not to include the underlying, uninfiltrated wood. [10] The sound sapwood also

[10] The completely decayed wood that surrounded those pieces of wood which remained intact within the log, was scraped off carefully before they were photographed.

was reduced to shavings and, after thorough drying, both samples were ground finely.

These samples of finely divided wood were first successively submitted to a preliminary extraction, without heating, for 24 hours with ether, 95 per cent alcohol, a 10 per cent solution of sodium hydroxide, and a 5 per cent solution of hydrochloric acid so that, when the decomposition products were extracted finally they would be free from many extraneous substances. Parallel tests were conducted on equal quantities of infiltrated wood and of the normal sapwood. The ethereal and alcoholic filtrates, in both cases, contained such exceedingly small amounts of substance that they were not further investigated. The alkaline filtrate from the sound wood residue, upon the addition of 90 per cent alcohol, gave a characteristic precipitate of xylan (wood gum). The alkaline filtrate from the infiltrated wood, however, upon the addition of 90 per cent alcohol gave a brown flocculent precipitate which, judging from its solubility and other chemical reactions, consisted of a mixture of two or more substances — at least very little wood gum was present. After the alkaline extraction the woody residues were washed and then subjected to extraction with a 5 per cent solution of hydrochloric acid for 24 hours. The acid filtrates thus obtained were practically colorless and the woody residues, in both cases, apparently remained unchanged. After this extraction the one from the infiltrated wood was, as far as could be determined by microscopic examination, as darkly colored as it was at the beginning of the original treatment.

Both the woody residues were then subjected to the action of an oxidizing agent (hydrochloric acid and potassium chlorate) after which, according to Temme (1885) and Frank (1884), the decomposition products are rendered soluble in alcohol. Münch ($1910^2$), however, considers that Temme and Frank are in error for giving this reaction (alcohol solubility after digestion with hydrochloric acid and potassium chlorate) as a characteristic of wound gum and shows that starch-containing cells which do not exhibit the slightest browning or gum formation likewise respond to this reaction. They did not continue to investigate the chemical nature of the brown decomposition product beyond finding that it was soluble in alcohol after digestion with a mixture of hydrochloric acid and potassium chlorate. This has been one of the chief objects of the present study.

Both the residues were then digested by boiling in a mixture of hydrochloric acid and potassium chlorate (5 gms. of potassium chlorate to 100 cc. of 80 per cent hydrochloric acid) for 15 minutes. The woody residues from this oxidizing treatment, after thorough washing, were compared. It was found that neither was destroyed by the strong oxidizing action but the residue from the infiltrated wood had lost all of its original blackish color and was only slightly darker than that from the sound wood. When examined under the microscope the cells of the ground infiltrated wood appeared to be filled with a light, reddish brown substance, while the cells of the sound wood also appeared to contain a similar substance but in smaller quantity. Both the oxidizing liquors left from this treatment were brown in color and when neutralized with sodium hydroxide gave brown precipitates respectively, the one in the case of the sound wood being the darker. These precipitates were not investigated further since they were deemed not to be of any material importance.

The woody residues left from the oxidizing treatment were then submitted to a cold extraction with absolute alcohol for 24 hours. In both cases the alcohol instantly assumed a brown hue due to material entering into solution. This treatment seemed to take most of the coloring substance from both woods, although the residues responded slightly to a second and even to a third extraction. The alcoholic filtrates were evaporated to dryness and weighed. Roughly estimated, about twice as much material was obtained from the infiltrated wood as from the sound wood. Both residues were dark brown in color and exhibited a conchoidal fracture. The one from the infiltrated wood was of the deeper hue.

Both alcoholic extracts were insoluble in cold or boiling water, concentrated hydrochloric acid, ether, petroleum ether, chloroform, carbon bisulphide, and carbon tetrachloride. Their specific gravities are indicated by the fact that they were not suspended in or floated upon any of the organic solvents tried of which the heaviest, carbon tetrachloride, has a specific gravity of 1.63. Neither, however, sank in concentrated sulphuric acid, whose specific gravity is 1.84. Both alcoholic extracts, however, were soluble in cold absolute alcohol, acetone, and a 10 per cent solution of sodium hydroxide. When the last named solution was neutralized with sulphuric acid the extracts, in both cases, were precipitated — that is to say they were insoluble in the exactly neutral sodium sulphate solution thus prepared. Both alcoholic extracts were soluble to a brown solution, but dissolved more slowly and without carbonization, when shaken in cold concentrated sulphuric acid. The alcoholic extract from the infiltrated wood was soluble in cold ammonium hydroxide, whereas that from the sound wood was soluble only by heating the reagent to boiling. When hydrochloric acid was added to the ammoniacal solutions until they were slightly acid both extracts were precipitated, leaving the solutions colorless in both cases.

None of the treatments thus far applied have secured a separation of the substances peculiar to the infiltrated wood and giving to it its distinguishing color. The solubilities and other properties of the respective extracts indicate that they are, for the most part, made up of like substances and in the case of the infiltrated wood, in addition to the materials originally present in the sound wood, there is present one or more decomposition products which, for a time at least, are little or not at all affected by the fungus producing the decomposition. The similarities of the substances decomposed by the oxidizing treatment, as regards solubility and behavior toward other reagents except the oxidizing reagent, show relationship between the original materials and the decomposition products here in question. The solubility relations of both indicate that, before oxidation, they would be classed with the hemicelluloses, but that they are so altered by oxidation as to become soluble, particularly in alcohol and acetone without losing their insolubility in sodium hydroxide and in acidulous salt solutions.

## SUMMARY.

1. The brown substance commonly occurring in dicotyledonous woods attacked by wood-destroying fungi is indicative of the first stage of the decomposition of the wood.

2. The formation of a similar and probably identical substance also occurs in wounds of living dicotyledonous trees and, under certain circumstances, in fallen woody parts where fungous growth may not be present. This is to be considered as due solely to oxidation of the woody substance without the stimulus afforded by the presence of wood-destroying fungi which would greatly hasten the decomposition.

3. Both decomposition products arise only after the death of the cells through the oxidation of their contents and certain constituents of their walls. This formation occurs most notably in the parenchyma cells.

4. The decomposition products formed in the decay of dicotyledonous woods infiltrate the cell walls to a greater or less extent, frequently becoming so abundant as to form numerous brown drops within the lumina of the cells. Such deposits appear in the wood as blackish zones of varying thickness which occur at first between decayed and undecayed areas and later separate areas in different stages of decay. Wood thus infiltrated is to be considered as pathologic heartwood.

5. The blackish zones are not constant in position since the decomposition products, which cause the discoloration, move forward with the advance of the decay in any part of the stem and ultimately disappear upon its completion within that part. The continual occurrence of the blackish zones between decayed and undecayed wood is due to the fact that the decomposition products are destroyed together with the wood while new ones are formed constantly from the wood as fast as it is attacked by the advancing fungus.

6. In the decay of coniferous woods the formation of decomposition products of similar nature to those studied here is very small in quantity as compared with those arising in the decay of dicotyledonous woods.

7. The formation of the brown decomposition products is dependent mainly upon the concurrence of three factors: (a) the presence of dead cells, (b) an optimum supply of moisture, and (c) a supply of oxygen sufficient to promote oxidation.

8. The partially decomposed material of woody plants forms a particularly vague and indefinite group of substances containing all the non-volatile products of fungal, enzymic, and oxidative actions on the plant residues. The resultant products are exceptionally resistant to chemical reagents.

9. It is evident that the cell contents and certain other substances, particularly the hemicellulose xylan (wood gum), that originally were combined with the cellulose to constitute the cell wall furnish the formative material which, through oxidation upon the entrance of air and the presence of water, coagulates to thick drops and gives rise to the decomposition products which ultimately infiltrate certain portions of the wood, causing them to appear as blackish zones.

10. In the wood of the pignut hickory the hemicellulose xylan (wood gum) is destroyed early in the grogress of the decay. In the early stages of the decomposition of the wood (in that portion infiltrated with the decomposition products

and appearing as a blackish zone) the wood gum, in its partially oxidized state, apparently is the substance which is responsible for most of the discoloration. Later, however, when the blackish zones advance and the decay becomes completed within that portion of wood which the decomposition products formerly occupied, the wood no longer responds to chemical tests for wood gum.

11. By the action of a strong oxidizing reagent on fresh sapwood a brown decomposition product can be prepared artificially which is essentially like that occurring naturally in dicotyledonous woods, whether in wounded areas of living trees, dead wood, or as the result of the action of wood-destroying fungi.

12. After subjecting both sound and infiltrated wood to the action of a strong oxiding reagent and extracting the products whose nature was changed by the action, the chemical properties of the respective extracts indicate that they are, for the greater part, made up of like substances. In the case of the infiltrated wood in addition to the materials originally present in the sound wood there is present one or more decomposition products which are temporarily left little or not at all affected by the fungus producing the decomposition. The solubility relations of the extracts obtained from both woods indicate that, before oxidation, they would be classed with the hemicelluloses but that they become greatly altered in nature by the action of the oxidizing reagents.

13. The decomposition products whose formation is due to the action of wood-destroying fungi have proven to be a group of substances analogous to or nearly identical with the decomposition products which arise under certain circumstances in dead wood that is entirely free from fungous attack and which have been known under the name "wound gum." Their formation is greatly accelerated by the presence of wood-destroying fungi which greatly hasten the decomposition and hence the oxidation.

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## Explanation of Plates.

### Plate I.

Effect of *Pyropolyporus igniarius* (L.) Murrill upon a living tree. Cross section of the trunk of a silver maple (Acer saccharinum Linn.) which bore but one fruiting body, this being the only external indication of disease. Note the thin black zones surrounding the completely decayed wood; also the place of entrance of the fungus at the upper left-hand corner, produced by the rotting of a dead lateral branch. Photo by courtesy of the U. S. Bureau of Plant Industry.

PLATE I.

PLATE II.

Cross section of a sugar maple (*Acer saccharum* Marsh.) log rotted by *Elfvingia megaloma* (Lév.) Murrill., X ½. Notice the irregularity of the black zones surrounding the areas in various stages of decay. This irregularity is due to the decay starting simultaneously from several centers.

PLATE II.

## Plate III.

The last portions of the sapwood of a hickory [*Hicoria glabra* (Mill.) Britton] log to be decomposed by the action of *Coriolus prolificans* (Fries) Murrill, the remainder of the sapwood being completely decayed. The completely disintegrated wood adhering to these comparatively sound pieces was removed by rubbing and scraping. Note the black color of the superficial portions of these pieces of undisintegrated wood. It was caused by the infiltration of abundant decomposition products into those portions immediately adjoining the completely decayed wood. The central piece (marked X) shows one of the pieces in transverse section.

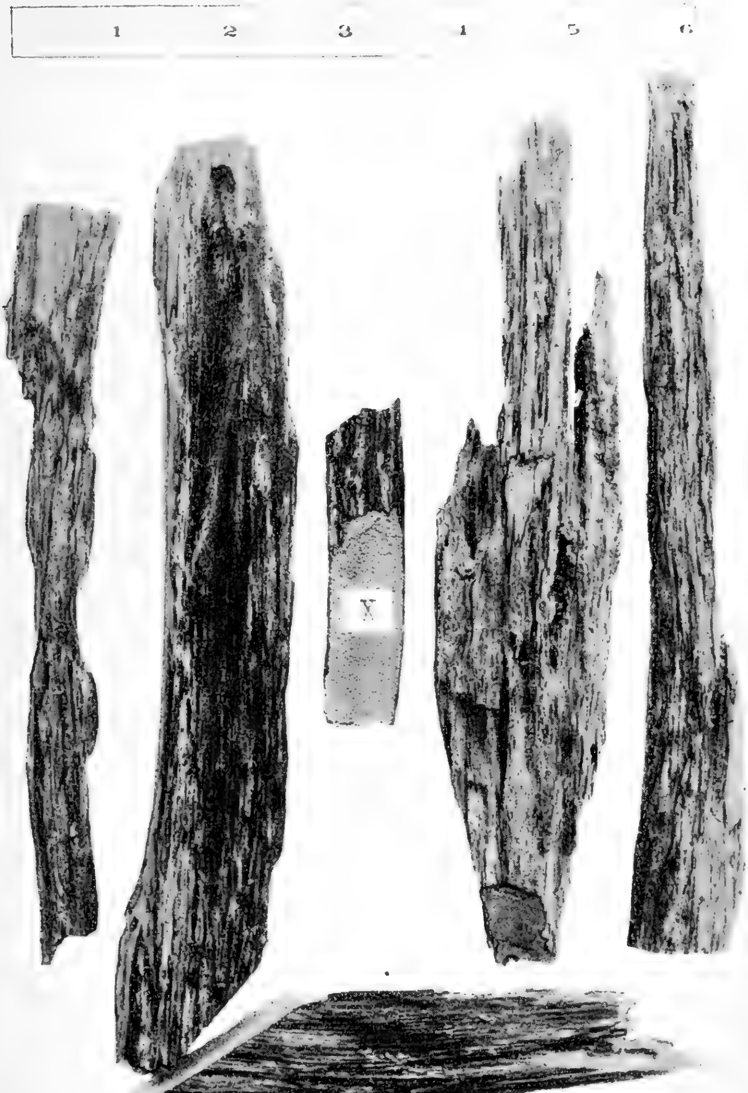

PLATE III.

## Plate IV.

Fig. 1. Photomicrograph of a cross section of a portion of the sapwood of *Hicoria minima* (Marsh.) Britton rotted by *Coriolus prolificans* (Fries) Murrill, showing a black zone in cross section, X 100. The wood at the right has been thoroughly decayed as the appearance of the cell walls will testify. At the left the wood is in the earlier stages of decay and is giving rise to decomposition products upon the advance of the decay. In the center is shown a back zone which separates the portions of wood in the different stages of decay.

Fig. 2. Photomicrograph of a radial section of a portion of the sapwood illustrated in Plate III, showing the formation of the brown drops of the decomposition products in the pith ray cells, X 100. The photograph was made of a portion of wood lying approximately one-half cm. within the external infiltrated portion.

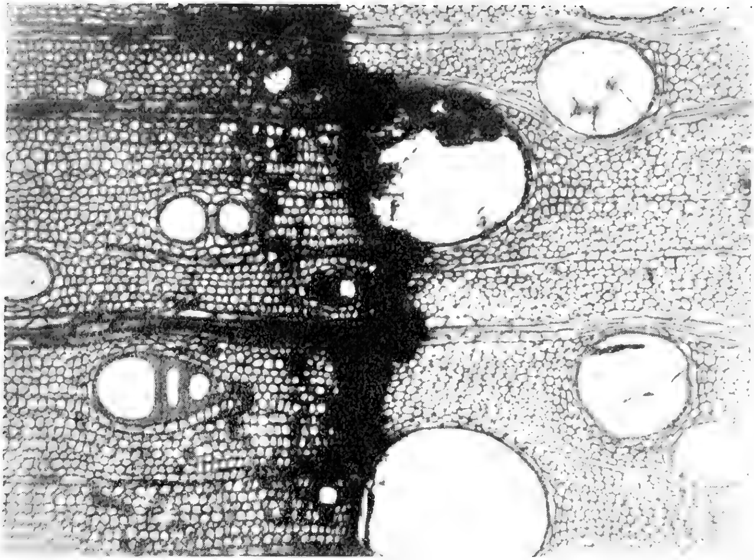

PLATE IV.

Plate V.

Camera lucida drawing of a pith ray illustrated in Plate IV, Fig. 2, showing in detail the formation of the brown drops of the decomposition products in the pith ray cells, X 650. Occasional fine fungal hyphae may be seen passing through the simple pits in the end walls of the pith ray cells.

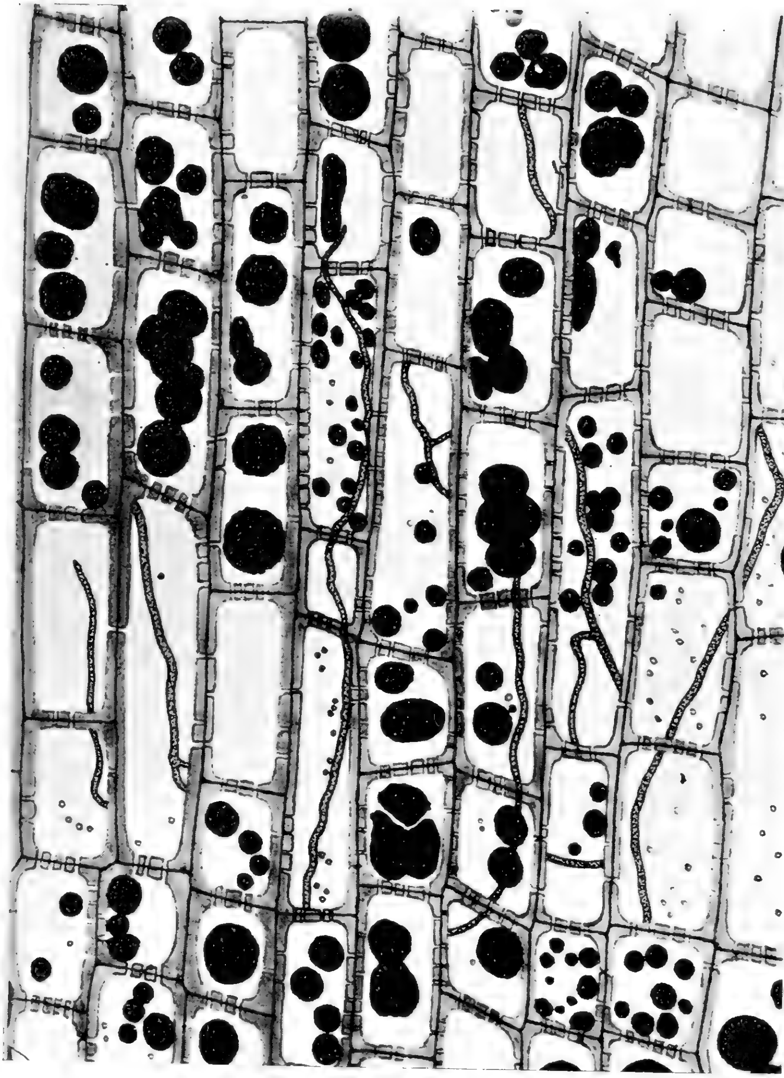

Plate V.

PLATE VI.

*Coriolus prolificans* (Fries) Murrill, on trunks of *Quercus coccinea* Muenchh. killed by a light surface fire. A two-foot rule is shown on the trunks. This photograph shows the general appearance and habit of growth of this extremely common sap-rotting fungus. It was principally the black zones of decomposition products formed in hickory wood as a result of its decay by this fungus that have been studied here.

Plate VI.

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ERNEST G. DUDLEY, A. B., 1908 (Leland Stanford Jr.); 1908–1909 (Yale Forest School),
*Assistant Professor of Forest Extension.*

WILLIAM A. GRUSE, A. B., 1913 (Johns Hopkins); A. M., 1915; Ph. D., 1916 (Wisconsin),
*Assistant Professor of Dendrological Chemistry.*
(Fuller Fund. On leave of absence.)

ALAN F. ARNOLD (Harvard),
*Instructor in Landscape Engineering.*
(On leave of absence.)

**FACULTY** — (*Continued*)

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CARL CHESWELL FORSAITH, A. B., 1913 (Dartmouth); A. M., 1914; Ph. D., 1917 (Harvard),
*Instructor in Forest Technology.*

HAROLD CAHILL BELYEA, A. B., 1908 (Mount Allison University); M. F., 1916 (Yale),
*Instructor in Forest Engineering.*

HIRAM LEROY HENDERSON, B. S., 1915 (Michigan),
*Instructor in Forest Utilization.*

ROBERT VERNON WILLIAMSON, B. S., 1909 (Oregon Agricultural College); M. S., 1917 (Michigan),
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JESSE L. ESSEX, A. B., 1914 (Wabash College); M. S., 1917 (Purdue),
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EDWIN N. HOPSON, Jr., A. B., 1917 (New York University),
*Research Assistant in Dendrological Chemistry.*
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ALVIN G. SMITH, B. S. (New York State College of Forestry),
*Field Assistant in Forest Investigations.*

WILFORD E. SANDERSON, B. S., 1917 (New York State College of Forestry),
*Field Assistant in Forest Investigations.*

DON M. BENEDICT, B. S., 1917 (Michigan),
*Laboratory Assistant in Botany.*

**FACULTY** — (*Concluded*)

EDGAR C. PEDDIE, B. S., 1917 (New York State College of Forestry),
*Instructor in Forest Extension.*

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ALFRED HUBERT WILLIAM POVAH, A. B., 1912; Ph. D., 1916 (Michigan)
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C. F. CURTIS RILEY, A. B., 1901 (Doane College); B. S., 1905 (University of Michigan); A. M., 1911 (Doane College); M. S., 1913 (Illinois),
*Special Lecturer in Animal Behavior.*

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LILLIAN M. LANG,
*Secretary to the Dean.*

WALTER W. CHIPMAN, B. S., 1893; A. M., 1904 (Wabash College),
*Assistant Treasurer.*

ELEANOR CHURCH, B. L. E., 1916 (Syracuse),
*Librarian.*

EDNA E. WHITELEY, B. L. E., 1916 (Syracuse),
*Recorder.*

## RELATION OF FISH AND OTHER WILD LIFE TO FORESTRY

"Forestry means not alone the growing of a crop of trees from the soil for the production of wood, but it includes as well the conservation of water by the forest and the perpetuation of the animal life of the forest where that is beneficial. Therefore, in all of its plans for investigative work in forestry in the State, the College has considered not only the value of the non-agricultural soils for the production of forests but the life of the forests and the forest waters, and the use of the forests and the forest waters in the most reasonable and effective way. In considering the question of forestry in this broad, constructive way, the College is not original but is merely using the same vision for the future which has been used during the past century in such European countries as Germany and France, who have made their forests so important a part of their industrial and commercial development."

HUGH P. BAKER, *Dean,*
*The New York State College of Forestry.*

"Forests are more than trees. They are rather land areas on which are associated various forms of plant and animal life. The forester must deal with all. Wild life is as essentially and legitimately an object of his care as are water, wood, and forage. Forest administration should be planned with a view to realizing all possible benefits from the land areas handled. It should take account of their indirect value for recreation and health as well as their value for the production of salable material; and of their value for the production of meat, hides and furs of all kinds as well as for the production of wood and the protection of water supplies."

H. S. GRAVES, *Chief Forester,*
*United States Forest Service.*

# PREFACE

The quotations on the opposite page express concisely the relation of fish to the administration of non-agricultural, forest lands and waters, as expressed by representative foresters. Dean Baker has clearly expressed the policy of this College toward these problems.

The present publication by Frank Collins Baker,* Zoological Investigator of the College of Forestry, is his second contribution toward our knowledge of the condition of fish life in Oneida Lake. It is devoted to a study of the amount of fish food produced in Lower South Bay of Oneida Lake. This is the first important quantitative study of fish food of the bottom ever made in America, and one of the two known to have been made in the fresh waters of the world. The kind and amount of food in our forest waters is now generally recognized to be one of the main factors influencing fish abundance and this study was made to increase our knowledge of the subject. Briefly stated, Mr. Baker's investigation shows that there is an abundant and varied population of invertebrate animals living upon the bottom of Lower South Bay, and of the kinds eaten by fish in large amounts. This fish food varies both in kind and amount with the character of the bottom materials, whether boulder, sand, mud, etc. By an actual count of the number of individual animals living upon limited sample areas, sand was found to be the most densely populated by fish food, and boulder bottom the least so.

The character and amount of plants was found to have a marked influence upon the kind and abundance of this fish food. Furthermore, by these quantitative studies it was made possible to calculate the relative abundance of the small herbi-

* Since the completion of this investigation Mr. Baker has accepted the position of Curator of the Natural History Museum, University of Illinois, Urbana, Illinois, where he goes with the best wishes of the College.

vorous and carnivorous animals, and to show rather precisely the dominance of those feeding upon plants over those feeding upon flesh. This fact gives additional support and emphasis to the importance of the vegetation in the production of fish food.

Depth of water is another factor of much influence. This investigation shows that the greatest amount of fish food is produced in shallow water of less than six feet, and that, in general, both in number and in kind these animals decline in variety and abundance with increasing depth.

Provisional estimates were made of the amount of food eaten by fish, in an effort to calculate the quantity of fish food which the bay can nourish. Very little accurate information seems to have been recorded on this subject. This fact emphasizes in a striking manner the urgent need of careful detailed investigation of the amount of food required by our common fish in nature per day, how much this varies with age, and with the season.

All of these observations are of much value scientifically, and in practical fish culture in working out comprehensive plans for the propagation and planting of fish, and for other phases of aquatic management of forest waters. These and other allied investigations now under way at the College of Forestry are to be used in building up a sound body of scientific facts on the ecology of fish and game, upon which, in the future, can be erected a better system of management of our forest waters and lands than is possible with our present defective knowledge. Working plans for aquatic management bear the same relation to cultivation of the waters as working plans for forests have to forest management and game plans to game management, and such plans can only be developed after the proper surveys have been made and all the factors correlated and organized on a practical basis.

CHARLES C. ADAMS,
*Professor of Forest Zoology.*

DEPARTMENT OF FOREST ZOOLOGY.

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CONTENTS—*Concluded*

## ILLUSTRATIONS

**ILLUSTRATIONS**—*Continued*



All photographs in the field were made by the author during July, 1916. In some of the quantitative figures, which are intended to show the general character of the fish food, it has not been possible to include all of the specimens on a 5 x 7 plate and a few individuals have been eft out or only partly included. In these cases the total number of ndividuals of the unit area are not shown on the plate.

# INTRODUCTION

The purpose of the investigation described in the present bulletin is to present facts concerning the amount of the food supply available for fish life in an important fish-producing lake whose physical character and fish are known with some degree of accuracy. For this purpose Lower South Bay, a well known and favorite fishing resort at the west end of Oneida Lake, was chosen for the field operations. This localtiy is easily and speedily reached from Syracuse by a trolley system having hourly schedules, a feature which renders this bay a favorite place for local fisherman to spend week-end vacations throughout the season. The field work was conducted during the month of July, when the weather was favorable and storms were at a minimum.

The inspiration for the investigation was received from the work of the previous year and from a study of Petersen's epoch-making quantitative studies of the biota of the marine waters of Denmark, carried on for many years and published in the fascinating series of reports issued by the Danish Biological Station. Several distinguished European ecologists have for many years studied the biota of the various waters of the northern parts of Europe in a quantitative manner. Among these Hensen's papers on the methods of plankton work and on the productivity of the sea ('95, '97), Apstein's studies of the fresh-water lakes of Holstein ('96), and Brandt's papers on the productivity of the sea ('99–'05) are noteworthy. These studies dealt almost exclusively, however, with the plankton of the sea and lakes, and took little or no account of the biota of the bottom, which is of great importance and furnishes a large part of the food of many fish and other animals. It should be noted, however, that Dahl ('93) studied the animal life of the brackish waters of the lower Elbe River and determined, by digging, the amount of life per square meter, at low tide. It remained for the Danish zoologist, Dr. C. G. Joh. Petersen, to devise apparatus and methods for a census of the life of the sea bottom by means of the examination of many samples of a unit area (see Bibliography). For these studies Petersen invented a bottom sampler which brought up a sample of the sea bottom one-tenth of a meter square, the layers of bottom soil being in their natural position. A series of these unit areas, when examined for the animal and vegetal life, gave a fairly accurate picture of the bottom of the sea, and this method enables the student to secure with this sampler a reasonably accurate census of the animal population of large areas of the bottom of both seas and inland waters.

Previous to Petersen's investigations the quantitative studies were chiefly confined to the plankton organisms, which were designated the "pastures of the sea" and which were believed to afford the greatest and most important food supply for fish and other marine animals. Petersen has shown, with the aid of the centrifuge, that the water is also filled with very fine particles of organic matter, called by him dust-fine-detritus, which far exceeds the plankton in amount and is thought to be of greater value as a source of food. In fact, the detritus should be included with the animals and plants usually recognized as forming the plankton, which should include any and all organic matter, alive or dead, that floats or is carried about in the water by means of currents. Petersen's methods of quantitative work places a new value on such investigations and should stimulate research in the direction of a census of our aquatic population, both marine and freshwater. Such studies are statistical and are based on the examination of many associational units. It is realized that the conditions of life in the sea are not exactly comparable with those of our inland lakes and streams, but the same general methods may be used, modified to meet local conditions, and the same kind of generalizations may be reached.

Recently, another European biologist, Sven Ekman ('15), evidently inspired by Petersen's work and methods, made an ecological, quantitative, and qualitative study of Lake Vätter, situated about 115 miles southwest of Stockholm, Sweden. A bottom sampler similar to Petersen's was devised by this author for obtaining material from unit areas. This sampler covers a larger area (5 dm. square or about 400 square inches, 20 inches square) than the Petersen dredge and seems almost too large for practical work. The area of about half that size (10 inches square) would seem preferable. This lake was very carefully studied, and temperatures, degrees of transparency, chemical characteristics, submerged vegetation, and types of bottom material are discussed at length. Plant detritus, apparently similar in character to the dust-fine-detritus of Petersen, is stated to be present. It is to be regretted that only the first part of this very interesting paper is available to me. The aims of Ekman are apparently similar to those of the present writer and it would be of great interest to compare the results of quantitative studies of those two lakes, one a deep lake (Sweden) and the other a comparatively shallow body of water.

In America, while much biological work has been done on the qualitative side of fresh waters, few quantitative studies have been made aside from that of the plankton (Birge, Marsh, Kofoid, etc.) and a rich and almost virgin field lies before the ecologist who has the opportunity to carry on this important line of investigation. Such studies not only advance the technical or scientific side of aquatic biology but also the economic, so that both general and applied science advance side by side. For example, in the present report the quantitative studies revealed several new species of algæ, a new insect, and five new mollusks, besides indicating the relative abundance of the different species under varying physical conditions; at the same time many facts were ascertained about the animals used by fish as food. Aquatic studies to be of the greatest value, at the present time, must be so complete that they will furnish data for answering a vast number of questions, both economic and scientific.

The area of Oneida Lake studied quantiatively embraces two localities. The larger locality, and the one containing the greater amount of quantitative data, embraces the territory of Lower South Bay, an area of 881 acres. The limits of this

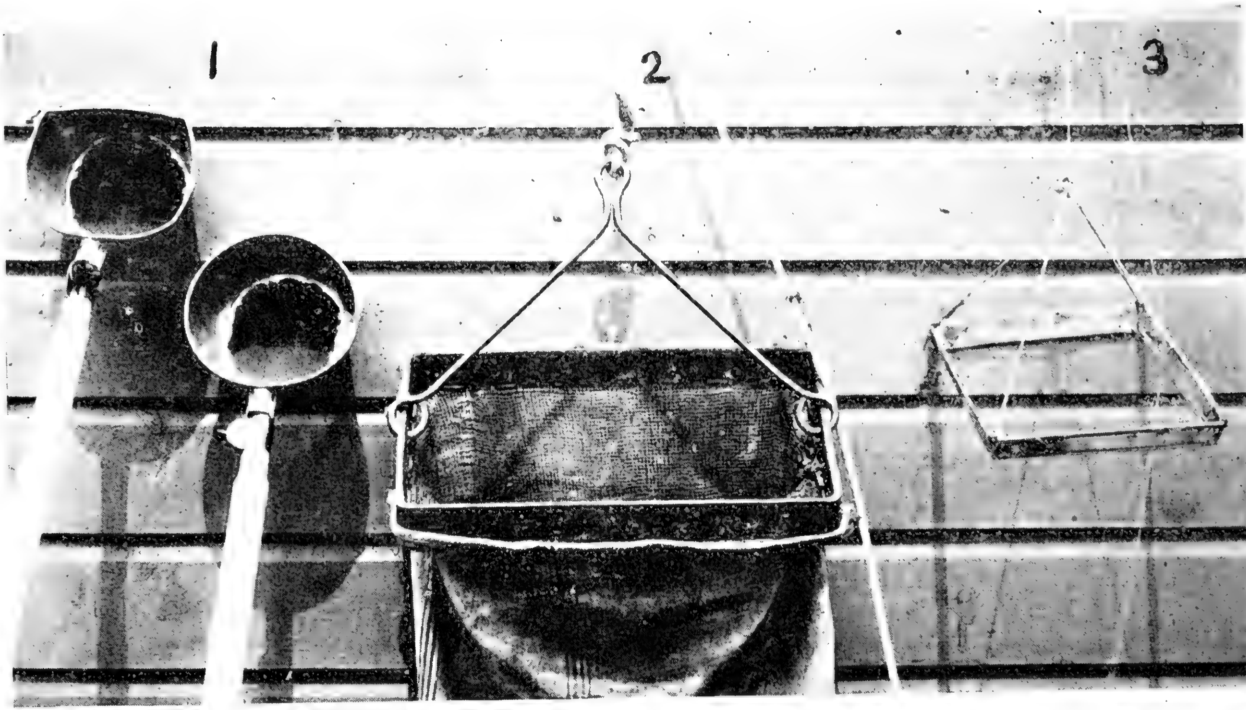



FIG. 2. Collecting apparatus: 1, Walker dipper-dredges, the one on the left is straightened to take up bottom material from an area 4 inches square (16 square inches or approximately 100 square cm.). 2, Dredge with rectangular metal frame for use in deep water. 3, Metal frame 8 inches square (64 square inches, or approximately 200 square cm.) for measuring the density of mussels population and vegetation.

bay on the east and north are bounded by a line running east from Long Point meeting a line drawn north from Norcross Point (see the map, figure 1). Outside this territory, areas near Dunham Island, in the deeper water south of Dunham Island and along the shore east of Norcross Point were studied quantitatively, these areas amounting to 283 acres. The total area studied quantitatively amounts to 1,164 acres.

**Equipment.** The equipment for collecting the material included a commodious row boat sufficiently flat-bottomed to be used in shallow water and also with the bottom rounded enough to resist the waves of the deeper water of the open lake when carrying on dredging operations. Its size afforded room for two persons with a considerable equipment of cans, nets, and collecting apparatus. It was not possible to secure a Petersen bottom-sampler and for the purpose of obtaining samples from a known area of bottom a Walker dipper (fig. 2, no. 1) made of copper with a very fine wire cloth bottom was flattened on one side. With this sampler the bottom soil material could be scraped up from an area 16 square inches (about 100 square cm.) in extent. The bottom layers are of course disturbed by this process but the dipper digs deep enough to secure those animals that burrow in the mud (*Hexagenia, Ephemera, Gomphus, Sphærium,* etc.). This apparatus was quite effective in water to the depth of six feet. It somewhat resembles Petersen's first bottom sampler, used in 1896, which was attached to a long pole for use in shallow water, although in shape the two instruments are very different. While this first sampler is characterized by Petersen as primitive it nevertheless gave good results (Petersen, '11, p. 5) and the sampler in use in Oneida Lake, although equally primitive, certainly has been valuable in producing a picture of the bottom of Oneida Lake. It shows that some areas are rich in life while other regions are poor in life. For further studies of this character it would seem important that a Petersen bottom sampler, or a similar instrument, be secured, as with this apparatus the units of material, especially in deep water, may be collected with greater facility and accuracy. A sampler with a greater collecting area, not less than 64 square inches (400 square cm.) would be an improvement, since with it the larger clams could be collected and included in the general estimate.

The deeper water (6–18 feet) was examined with a large dredge, the rectangular metal framework being 16 inches wide (fig. 2, no. 2). For estimating the number of clams in shallow water (1–3 feet), a square metal frame eight inches square (20 cm. square) was made and found effective for this purpose as well as for measuring the density of plant growth (see fig. 2, no. 3). It is regretted that apparatus for taking temperatures and for indicating the degree of transparency were not available. Thermometers intended for this purpose were found to be imperfect when used. The photographs were made with a 5 x 7 view camera. The photographs of the contents of certain unit areas figured in the bulletin were obtained by placing the camera upon a frame in a vertical position, pointing downward. The material was sorted in large white crockery plates and the photograph taken with the material under water.

**Methods.** All collecting was done from the row boat previously mentioned. Each dredging was made by the writer and the material placed in a suitable vial by an assistant, who also recorded, by dictation, depth, distance from shore, character of bottom, and the general characteristics of the vegetation of the habitat. On boulder bottoms, where the bottom sampler could not be used, a number of boulders were collected and measured and the life contained on each was carefully removed and placed in vials for examination. On gravel bottoms it was usually possible to use the bottom sampler. In a few cases but one sample was taken from each habitat, but in the majority of habitats examined several samples were obtained, giving a better average in the general results. All material was first preserved in a 5 per cent solution of formaldehyde. It was subsequently found, however, that this preservative had a dissolving effect on such animals as mollusks, causing the shells to disintegrate or become very soft. Later the entire collections were transferred to 80 per cent alcohol.

The dredging in deep water was difficult. Experiments were first made in shallow water; the 16 inch dredge was dragged for a distance of 48 inches, providing a square area of 168 square inches (16 x 48), or the equivalent of 48 of the 16 square inch shallow water units. Of course the error in this was much greater than in the shallow water dredgings with the Walker dipper, but a special effort was made to make the work as accurate as possible. In shallow water there were a large number of dredgings, in all 544, the large number reducing the error considerably and making the results fairly reliable. In the deeper water only 18 dredgings were made so that both the small number and the difficulty of taking an accurately measured sample made the error much greater. On the other hand the animals decline both in number of species and in individuals, and probably in importance as fish food, with depth, so that recognizing these limitations the calculations have been tabulated and used as in shallower water.

This material has been carefully examined quantitatively, the groups represented in each station lot being sorted and counted, a labor the monotony of which can be realized only by those who have engaged in similar statistical work. The sorting and enumeration of individuals was performed in glass dishes about two inches in diameter. For this purpose the glass dishes known as Syracuse watch glasses were used. A hand lens of 5 and 10 diameters and a compound microscope with powers up to 50 diameters were used in sorting the material. When finally sorted and made ready for examination by specialists the collections occupied more than 1500 vials. All of the data supplied by the material has been plotted on the quantitative tables in the body of this report.

Petersen both counted and weighed the animals used for his quantitative studies, giving "dried" and alcoholic weight ('11, pp. 50–53). In the present report only the *number of animals* per unit area has been used. It may be of value in future investigations of this character not only to weigh the animal matter but also to calculate the food value in terms of proteid, fat, etc., as has been done by many European investigators in marine studies (see Johnstone, '08, pp. 189–191).

For the present purpose it has seemed sufficient to enumerate the individuals present in the body of water under examination.

**Acknowledgments.** The studies embodied in the follow-pages have been carried on under the direction of Doctor Chas. C. Adams, Professor of Forest Zoology in The New York State College of Forestry, and to him and to Dean Hugh P. Baker of the College the writer is indebted for the opportunity of continuing the investigations begun in 1915. As in the past the author has received valuable counsel and helpful suggestion from Doctor Adams as the work progressed, including the use of his library. To the staff of the summer laboratory, consisting, in addition to Dr. Adams, of Professor T. L. Hankinson, Dr. Paul S. Welch, and Mr. A. G. Whitney, thanks are especially due for aid in collecting material and for suggestions during the progress of the field work. To his wife, Mrs. Lillian M. Baker, the author is particularly indebted for the careful manner in which the records of the quantitative stations were made and for assistance in making the collections and in preparing them for future examination. Mention should also be made of Mrs. Baker's assistance in the preparation of the quantitative tables.

Quantitative investigations of this character are largely cooperative, and the present report is no exception, as upwards of twenty-two specialists have examined and reported upon the various groups represented in the collections. To those who assisted in this work, whose names are given below, the author wishes to return his sincere thanks. In many cases the material was of large amount and in difficult groups, but the work of examination has been uniformly cheerfully and carefully done, even at personal inconvenience. The assistance of these specialists is truly altruistic and is a notable example of the high ideals of the majority of American scientific workers:

Dr. Cornelius Betten, New York State College of Agriculture, Ithaca, N. Y. **Trichoptera.**

Mr. Wm. J. Gerhard, Field Museum of Natural History, Chicago, Ill. **Coleoptera** and **Hemiptera.**

Prof. T. L. Hankinson, Eastern Illinois State Normal, Charleston, Ill. **Pisces.**

Dr. Nathan A. Harvey, State Normal College, Ypsilanti, Mich.
**Poritera.**

Dr. O. A. Johannsen, Cornell University, Ithaca, N. Y.
**Diptera.**

Mr. Chancey Juday, University of Wisconsin, Madison, Wis.
**Cladocera.**

Dr. C. Dwight Marsh, Bureau of Plant Industry, Washington, D. C.
**Copepoda.**

Dr. Ruth Marshall, Lane Technical School, Chicago, Ill.
**Acarina.**

Dr. J. Percy Moore, University of Pennsylvania, Philadelphia, Pa.
**Hirudinea.**

Dr. James G. Needham, Cornell University, Ithaca, N. Y.
**Odonata** and **Ephemerida.**

Dr. A. E. Ortmann, Carnegie Museum, Pittsburgh, Pa.
**Cambarus.**

Dr. H. S. Pepoon, Lake View High School, Chicago, Ill.
**Plants.**

Dr. H. A. Pilsbry, Academy of Natural Sciences, Philadelphia, Pa.
**Amnicolidæ,** etc.

Dr. R. W. Sharpe, DeWitt Clinton High School, Brooklyn, N. Y.
**Ostracoda.**

Prof. Frank Smith, University of Illinois, Urbana, Ill.
**Porifera.**

Dr. Victor Sterki, Carnegie Museum, Pittsburgh, Pa.
**Sphæriidæ.**

Miss Caroline E. Stringer, High School, Omaha, Neb.
**Planaria.**

Dr. E. N. Transeau, Ohio State University, Columbus, Ohio.
**Algæ.**

United States National Museum, Washington, D. C.
**Isopoda.**

Dr. Bryant Walker, Detroit, Mich. **Ancylidæ, Amnicolidæ,** etc.

Miss Ada L. Weckel, Oak Park High School, Oak Park, Ill.
**Amphipoda.**

Dr. Paul S. Welch, Kansas State Agricultural College, Manhattan, Kans. **Oligochæta, Lepidoptera.**

The need for investigations of the kind described in this bulletin is clearly indicated and recommended in a recent report of the Commissioner of Fisheries (Smith, '16, p. 42).

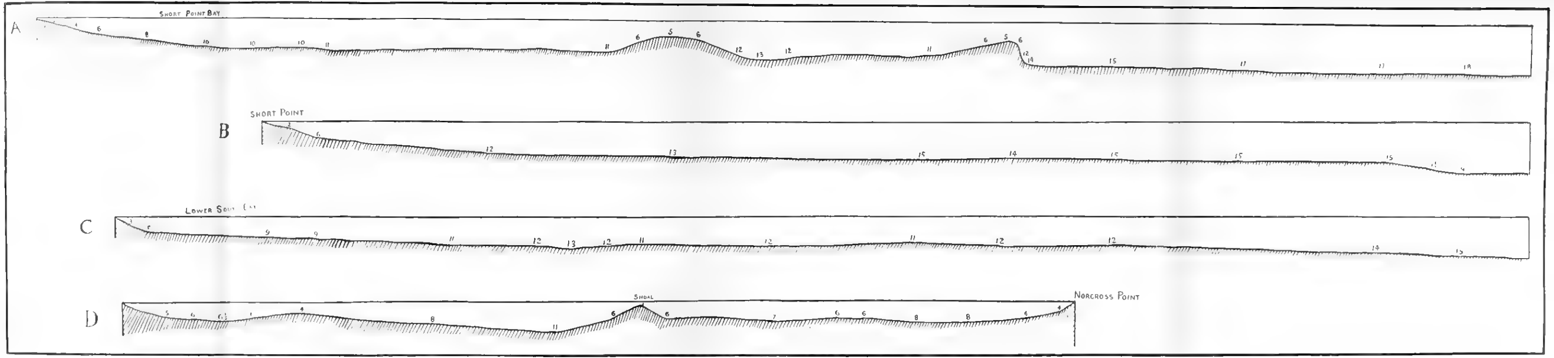
Writing of investigations relating to fresh-water fishes, Commissioner Smith says: "The fishery problems of fresh-water are undoubtedly simpler than those of the seas, but they are certainly less directly approachable than the problems of agriculture which have met their solutions. It is not surprising, therefore, that, throughout the country in matters of fish culture, there is yet too little serious endeavor to find real causes or to apply appropriate remedies. Year by year the Bureau is devoting more careful and fitting attention to the problems of fresh-water fisheries, and some of its principal activities in this field may be referred to.

"The problem of fish culture, at least as referring to pond fishes, is primarily one of food supply. Our knowledge of the food of fishes is as yet seriously inadequate. The food taken by fishes varies with the species, with sizes and age of the fish, with the season of the year, and with the abundance of the various kinds of food materials present in different bodies of water. A few observations in one locality or at one season of the year afford no criterion for the conclusions that we may seek to draw, for an appraisal of the possibilities of fish production in any body of water, for an understanding of the variations in the sizes attained by a given species of fish in different bodies of water, and for the direction of our efforts to promote an abundant and reasonably constant supply of food under all conditions subject to control."

The favorable comments on the bulletin previously issued on the "Relation of Mollusks to Fish in Oneida Lake" leads the author to hope that the present bulletin may be found useful, not only for the data which it contains but also in stimulating more students to enter this interesting and important field of study and investigation.

SYRACUSE, July 12, 1917.

DEPARTMENT OF FOREST ZOOLOGY.




[illegible] m east to west through Lower South Bay. The depths of water are given in feet. The position of all profiles [illegible] indicated on the map, figure [illegible]

## TOPOGRAPHY AND HYDROGRAPHY OF LOWER SOUTH BAY

### General Discussion (see map, figure 1)

The outline of the shore of Oneida Lake is quite irregular in many places, forming bays or coves of greater or less extent. The majority of these are of small size but there are four indentations of good size. If a map of the lake be examined it will be noted that two of these bays are at the wide east end and two at the narrow west end. South Bay lies at the extreme southeast corner, is about one by two miles in extent and covers an area of approximately 850 acres. Lakeport Bay is on the south shore, near the east end, and is about two-thirds as large as South Bay. Big Bay lies at the extreme northwest corner of the lake and extends into the land in the form of a wide sack. It has an area of 867 acres, and is one of the larger bays of the lake. Finally, there is Lower South Bay at the southwest corner of the lake, which is approximately one and five-eighths miles long and a mile wide, and has an area of about 881 acres. This is the only bay of the lake which is strikingly enclosed and for this reason it is of interest from an ecological as well as a physiographic standpoint. The other three bays are all open bodies of water receiving the full force of the winds and waves at certain times. Big Bay is protected partially by the higher ground at the north end and east side but is widely open at the lakeward end.

Lower South Bay is somewhat quadrate in form and is almost twice as long as wide. On the north the waters of the bay are protected by the long and narrow piece of land known as Long Point, which extends eastward into the lake for the distance of nearly seven-eighths of a mile. Beyond this point, however, there are shallows and bars extending in an eastward direction for about three-fourths of a mile, so that the bay may be said to be protected on the north by a barrier, more or less effective, for the distance of a mile and a half. The opening of the bay on the east side, where the deeper water lies, is only half a mile wide. Frenchman and Dunham Islands also

FIG. 5. Dunham and Frenchman Islands from Becker's Landing, Oneida Lake. Dunham Island is on the right.

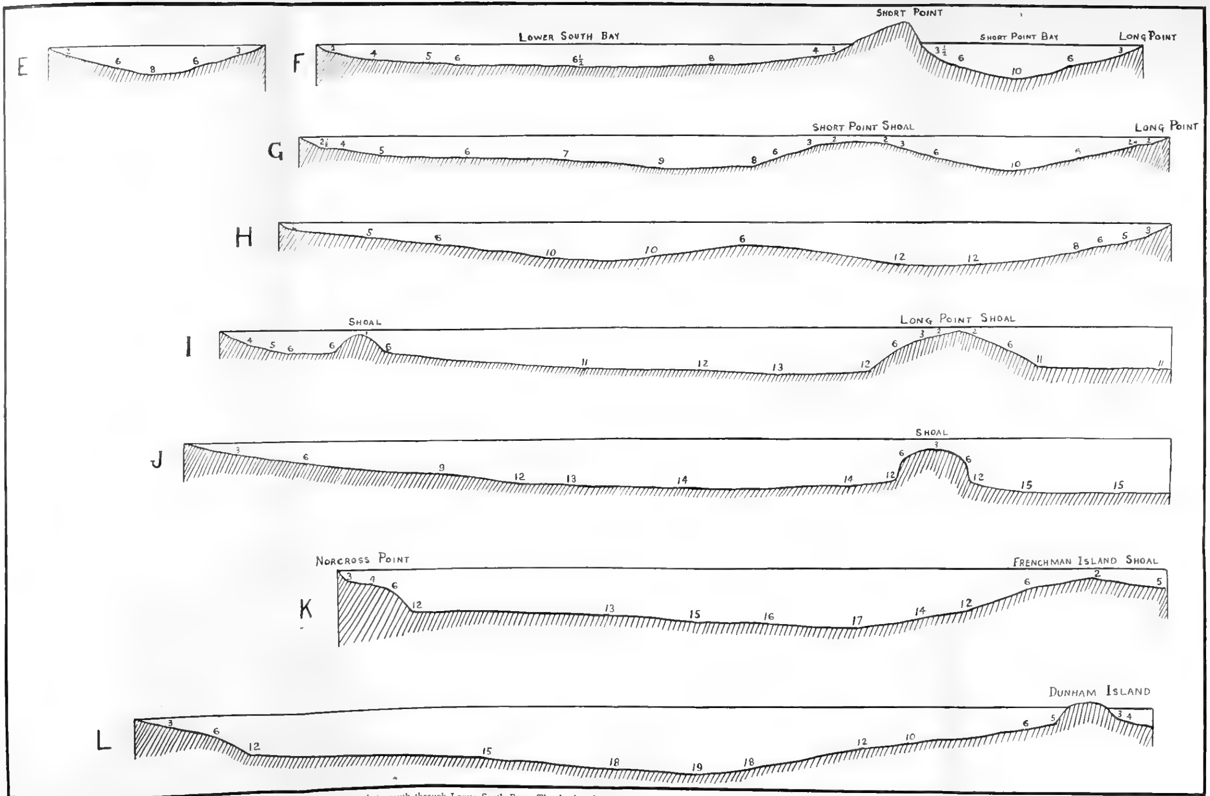



FIG. 4 Profiles from north to south through Lower South Bay. The depths of water are given in feet. The position of all profiles is indicated on the map, figure 1

help to protect the bay from severe northeast winds. A small bay, known as Short Point Bay, lies at the extreme northwest end of Lower South Bay. This body of water is about a third of a mile long and a quarter of a mile wide and covers an area of approximately 53 acres. It is protected on the north by Long Point and on the south by Short Point, and has muddy shores while Lower South Bay, being less protected by land areas, has sandy or rocky shores. The irregular headlands and points are being cut away and the eroded material is being carried into the bays and building up the shores.

The land bordering Lower South Bay is of two general types, low-swampy and high-terrace. The former condition prevails from the end of Conway Point westward bordering the whole of Short Point Bay, the entire west side of Lower South Bay, and the south side for the distance of a third of a mile eastward from the west shore. Long Point is from a foot to three feet above the level of the water, but in many places bordering Short Point Bay and Lower South Bay the land is so low that the east winds at times submerge large areas. There is, however, a piece of land west of Short Point, here designated Conway Point, which rises upwards of eight feet above lake level. The whole region for a mile and a half west of Lower South Bay is a vast swamp.

On the south shore of Lower South Bay, about a third of a mile from the west side, the land rises to form a marked terrace ten and twenty feet above the lake (380 and 390 feet above sea level) and this continues around the south and east sides of the bay and around Norcross Point and borders the south short of Oneida Lake. This seems to be a true lake terrace indicating a former and higher level of the lake. It may be seen on both the north and south shores of Oneida Lake, though in places it is at a considerable distance from the shore, the intervening space, usually swampy, indicating the position of a submerged, shallow, plain-like area bordering the shore of the ancient, larger lake. The post-glacial history of this region explains the presence of this terrace, which was formed during or just after the Rome outlet stage of Glacial Lake Iroquois.

FIG. 6. Long Point looking east toward end. Habitat No. x. near a summer cottage. The rocky shore and the absence

The terrace which borders the south shore of Lower South Bay is the most conspicuous part of the landscape and the summer cottagers have taken advantage of this natural feature and have used it as a site for their summer residences. Many an ardent angler has thus built his summer home on the high and dry terrace formed and left by the waters of this ancient lake and has tasted the delights of being a successful fisherman in the lake left by the receding waters of this old outlet. In this, as in many another instance, the forces of nature have provided man with both a building site, a pleasure ground, and a place from which to gather a food supply both abundant and easily secured.

The basin of Lower South Bay is comparatively shallow, being saucer-shaped, as is the basin of the entire lake, a feature well shown in the profiles, figures 3 and 4. A subaqueous lake terrace is present in some places, usually where the water is active and where the material of the bottom is sand, gravel, or boulders. In a very few cases the slope of this subaqueous terrace is very steep, examples being shown in sections A, F, J, and L of the profiles. Several of these steep slopes border shoals which have been formed off points. In this character of the slope Oneida Lake differs radically from the deep lakes of the Finger Lake group, and the deep lakes of Wisconsin, where the slope is as steep as sand will lie (Birge and Juday '12; Reighard '13, pp. 119–222). The subaqueous lake terrace bordering the shore in the vicinity of Lower South Bay is 300 or 400 feet in width and the water deepens gradually to six feet where it suddenly drops to 12 feet. On shoals and bordering Dunham and Frenchman Islands, the slope in some cases drops suddenly into deep water, the terrace being very narrow and steep (see A, J, and L of profiles).

In Lower South Bay there are no subaqueous terraces of this character, except bordering the points and shoals. The shores slope gradually and more or less uniformly into deeper water, the gradient being about a foot in 200 feet or half of one per cent (see profiles A to J). The greater part of the bay is a level area of fairly uniform depth. The profiles show a gradual deepening toward the east end of the bay where a depth

FIG. 7. Long Point, west of summer cottage, Habitat No. xiii. Note the heavy growth of Water Willow and American Bulrush. In deeper water the Lake Bulrush grows abundantly.

of 15 feet occurs. Farther east, between Norcross Point and Dunham Island, a depth of 19 feet is reached. The deepening continues gradually eastward in the lake until the maximum (55 feet) is reached off Cleveland.

## Description of Characteristic Bottom Areas

The basin of Lower South Bay may be divided into five areas, the distinctions being based on the character of the material forming the bottom of the bay. These are boulder, gravel, sand, clay, and black mud.

**Boulder and Gravel Areas.** Boulder and gravel areas are confined to the points and to the more exposed shores where the full force of the waves has carried away the sand and finer material. The gravelly areas usually lie just outside the boulder territory. In size the stony areas, including both gravel and boulders, which are often so closely associated as to be almost inseparable in large areas, range from gravel stones a half inch or less in diameter to boulders several feet in greatest diameter. The stony bottom usually extends to a depth of four feet but in several places it was noted at a depth of 5 and 6 feet and at a distance of about a thousand feet from the shore. The largest boulder deposit occurs at the end of Long Point where it extends upwards of 1,000 feet into the lake and has an area of some 370,000 square feet. An area of boulders at the end of Short Point is estimated to cover about 200,000 square feet. Other small gravel and boulder territory, on shoals and bordering points, make a total estimated area of 20 acres.

Outside the bay proper, there is a large area of boulder shore, extending from Norcross Point eastward along the south shore of Oneida Lake. This territory is upwards of 3,600 feet long and from 100 to 250 feet wide and embraces an area of about 740,000 square feet, or 17 acres. The boulders here extend to a depth of six feet. Several hundred feet north of the boulder shore, between the main land and Dunham Island, there is an area of gravel and sandy mud at a depth of 15 feet, which extends east and west for a distance of 1,400

Fig. 8. Short Point Bay from head of bay looking southeast. **The densest** shore vegetation in the Lower South Bay region occurs near the shore; in the distance is seen Habitat No. xxxi. In the middle distance a heavy growth of Lake Bulrush may be seen (Habitat No. xxxiii); in the foreground (Habitat No. xxxii) is noted an absence of gross vegetation; the bottom is of hard sand. The shore is lined with Swamp Loosestrife, and a few American Bulrush.

feet or more and must be upwards of a hundred feet wide. How far this streak of gravel may extend is not known as only three dredgings were made. It is probably to be found for a long distance east and west bordering the south shore of the lake. Mr. Fred Becker and other fishermen first reported this deposit to me and dredging corroborated their observations.

Other boulder areas of small extent occur at the west end of Dunham Island and on several shoals between Dunham and Frenchman Islands. On the boulder shores, especially when the lake lies at the bottom of a land terrace, as the shore east from Norcross Point, a line of boulders is usually found which is probably comparable to the ice rampart bordering the shores of other lakes. A typical ice rampart, however, was not observed by the writer on the shores of Oneida Lake, though such may exist.

**Sand Bottom Areas.** Sand areas are of wide extent in Lower South Bay, occurring in places where there is more or less protection from the waves, either by natural barriers or by depth of water. Sand usually borders the boulder and gravel territory where the water is five or six feet deep. On these sand bottoms the water ranges from a few inches to five or six feet in depth but in one spot it was found at a depth of 14 feet. Extensive sand areas occur on the south shore of Long Point, from the end westward for nearly 3,500 feet. These are from 150 to 400 feet wide. An area fully 900 feet long and having a maximum width of 400 feet occupies the head of Short Point Bay. At the end of Conway Point, in Conway Bay, and on Short Point, large sand bottom areas occur. The west shore of Lower South Bay, from south of Conway's house to the southwest corner of the bay, a distance of about 4,000 feet, has a border of sandy beach 50 to 100 feet in width. The largest sand bottom areas occur on the south shore of the bay, extending from Thierre's landing eastward to Norcross Point, embracing an area of approximately 38.34 acres, or 1,670,000 square feet.

On the large sand bottom areas bordering the west side of Short Point Bay, where there is little vegetation, the sand is

FIG. 9. Short Point, as seen looking southeast from Conway Point. The isolated trees stand at the end of the Point. Conway Bay in the foreground. The gross vegetation in the bay is Water Willow and Lake Bulrush.

more or less shifting and ripple marks are formed. In this kind of a habitat life is usually scarce. On the boulder points and along some shores the sand is also of a shifting nature. On the west side of Lower South Bay, the sand bordering the shore is more or less mixed with marly clay, which forms a binding medium. The total area of sand bottom in Lower South Bay is estimated to be upwards of 85 acres in extent.

Outside of the bay some sand bottom territory occurs. At the west end of Dunham Island, between this land and Frenchman Island, a sand area of about 38 acres occurs, the water ranging from two to four feet deep. Only a small portion of this territory is shown on the map. Sand also borders the lakeward side of the boulder area bordering the south shore of the lake east of Norcross Point in water from four to six feet deep. Sand is mixed with gravel in the area dredged between the main land and Dunham Island in water 14–15 feet deep.

**Clay Bottom Areas.** A rather stiff clay occurs abundantly in several localities, especially in the west end of Lower South Bay, where there is an area extending from Short Point around the bay eastward to Thierre's landing, a distance of nearly 7,500 feet, and approximating 4,007,500 square feet, or about 92 acres. A small portion of this area west of Thierre's landing, embracing some 220,000 square feet (about five acres) is more or less mixed with fine sand. Typical clay was noted only in the west and southwest part of the bay. Clay bottom occurs in water from two to seven feet deep. In most places there is no sharp line of demarcation between the different types of bottom soil — sand, clay, mud, etc.— the coarser grading into the finer without marked break. The boulder and gravel areas, however, frequently change suddenly into sand areas, especially when the water rapidly deepens or when the gravel or boulder area extends to the edge of a barrier, as a point of land. Such occur on Long Point and Short Point.

**Mud Bottom Areas.** Over the deeper part of the bay, beyond the 6-foot contour, the bottom is covered with a soft, black mud. The bottom of the small protected bays bordering

Fig. 10. Lower South Bay. Shore southwest of Short Point (Habitat No. lvi). The shore is bordered with Cat-tails, and they, on the lakeward side, by American Bulrush. Colonies of Pickerel-weed occur among the Cat-tails.

the south short of Long Point are all of this material, as is a large tract bordering the south shore of Short Point Bay. The water in these small bays ranges from two to five feet in depth. It is estimated that there are upwards of 684 acres of mud bottom in Lower South Bay and Short Point Bay. The deepest water noted in the bay was 15 feet, which occurred in the entrance to the east. Beyond this place, between the main land and Dunham Island, mud occurs at a depth of 18 feet and extends over nearly all of this deep water area. The bottom material here is soft, black, and oozy.

To recapitulate, the five characteristic types of bottom in Lower South Bay aggregate 881 acres, divided approximately as follows:

| | | |
|---|---|---|
| Boulder and gravel | 20 | acres |
| Sand | 85 | " |
| Clay | 92 | " |
| Mud | 684 | " |
| Total acreage | 881 | |

This difference of bottom material is due to the varying physical conditions in the lake, such as exposed and protected shores, depth of water, etc. Many of these conditions may be met with as one proceeds lakeward from the shore, boulders on an exposed point in shallow water (two to three feet), gravel in water deep enough to be less effected by the full force of the waves (three to five feet), sand in still deeper water (four to six feet), sandy clay in water deep enough to be out of reach of the shallow waves (six to eight feet), and mud in the deepest water (seven to fifteen feet). That the animals and plants are influenced by these physical factors will be shown in a subsequent chapter. The absence of beach pools, so characteristic of many of the lakes of Michigan (H. B. Baker, '11, '14) and Wisconsin (F. C. Baker, '11) was noted in the west end of Oneida Lake.

Over much of the bottom there lies a covering of organic material consisting of small plant fragments, pieces of wood,

FIG. 11. Looking west from end of Short Point into Lower South Bay, at the edge of Short Point. The Water Willow in the foreground marks the edge of the boulder area on Short Point. In the distance the heavy growth of vegetation consists of Water Willow, Lake Bulrush, the two Water Lilies, Pickerel-weed, and a number of pondweeds (*Potamogeton*). Habitats Nos. li to liv.

plant seeds, crustacean skeletons, fragments of shells, caddis-fly cases, the hard coverings of insects, and a large amount of fine, almost dust-fine, material. This bottom debris corresponds to Petersen's "dust-fine detritus," first noted on the sea bottom in Danish waters (Petersen, '11, p. 6; Baker, '16, pp. 120–152). In some places this material is of a flocculent character representing probably the decomposing soft parts of some of the animals of the lake. All of this bottom material is probably of great value as a source of food supply, not only for the bottom mud eating fish, but for many animals which are the food of fish. This matter is discussed in a later chapter. In Lower South Bay and Short Point Bay the bottom is almost completely covered with filamentous, as well as unicellular, algæ which forms a dense blanket in many places. This will be more fully noted in the chapter on vegetation and in the discussions of the bottom inhabiting animals.

The clearness of the water was noted at different dredging stations. The instrument used for measuring the density of clams and also of the vegetation was a square frame of bright tin. This was clearly seen at a depth of seven feet in Lower South Bay. Owing to the thickness of the vegetation in most places it was impossible to see the bottom or even the instrument when lowered in water deeper than six feet. The white disc generally used in such measurements was not available for study at this time.* Temperatures were planned for but the deep sea thermometers were found to be broken when we reached the lake, and there was not time to procure new ones.

The variety of material forming the bottom of the bay and the adjacent part of the lake makes possible an abundant development of plant life, providing almost every kind of environment, from a quiet, pond-like habitat with mud bottom,

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* While conducting field work in September, 1917, opportunity was given for observing the transparency of the water of the west end of Oneida Lake. In the channel opposite Nicholson Bay a white tile six inches square disappeared at a depth of 9 feet 8 inches. In the middle of the lake between Walnut Point and Shaw Point opposite Frenchman Island, the white tile disappeared at a depth of 10 feet. Both experiments were made in the middle of the afternoon when the sun was shining brightly. The water was clouded with plankton.

FIG. 12. West side of Lower South Bay below Short Point. The absence of gross aquatic vegetation is noteworthy. Habitat No. lxiv.

to the heavy surf of the exposed boulder points. The abundance of plant life is also very favorable for the production of large quantities of animal life, upon which fish largely depend for food, and the habitats afford good breeding sites for the fish living in the lake. The bay seems especially favorable for those fish which build nests, such as black bass, rock bass, etc.

Fig. 13. South side Lower South Bay west of Thierre's Landing, near Habitat No. xciii. The heavy growth of Cat-tails bordering the shore and the equally heavy growth of American Bulrush and Lake Bulrush bordering the Cat-tail zone on the lakeward side are especially notable.

# THE PLANT ASSOCIATIONS OF LOWER SOUTH BAY

## INTRODUCTION

Fish and most other aquatic animals are absolutely dependent, in the ultimate analysis, upon plant life for their food and development. Embody ('15, p. 239) admirably sums up the reasons for this dependence under five heads, as follows:

1. They constitute the principal food of a few fishes.
2. Directly or indirectly they furnish food and shelter to a host of small organisms that are eaten by fishes.
3. They are necessary in the spawning activities of certain fishes.
4. They purify the water by taking obnoxious substances including carbonic acid gas exhaled by aquatic animals, and by giving back oxygen.
5. They protect the water underneath them and the pond bottom from the heat of the sun.

A sixth reason might be added, that they provide a binding medium for holding the material of the bottom together.

Titcomb ('09, p. 6) clearly indicates the great value of plant life when he says: " Through the necessity for natural food, then, comes the primary importance of aquatic plants in pond culture. All animal life is dependent, directly or indirectly, upon plant life, the minute forms as well as many of the larger feeding directly upon plants, and the herbivorous species in turn serving as food for the carnivorous. The young fishes feed upon small crustaceans and other forms which are abundant only in an environment with abundant vegetation. Aquatic plants are therefore the food-producing agency in pond-culture, and are accordingly indispensable." Titcomb also rates plants as of great value in properly aerating the body of water and in holding the soil of the bottom in place.

Decaying plants are objectionable because of certain poisonous subatances thrown off, and a plant may also be obnoxious because of its too luxuriant growth which chokes the water and makes an unfavorable environment for fish as well as for

FIG. 14. Steamboat landing at Lower South Bay, viewed from the southeast corner of Lower South Bay, Habitat No. cxvii.

other animals. Dawson ('11, p. 29) has shown that this is sometimes the case with the fresh-water pulmonate gastropods, none being present where the vegetation had completely occupied quiet, pond-like bodies of water. The submergent type of vegetation is of the greater value, providing support and food for animals, aerating the water, and affording shelter for fish and other animals. Many of these plants remain green throughout the winter. The emergent type of vegetation is of value, although secondary to that of the submergent type. The water-lilies afford shade for fish.

## Description of Characteristic Plant Habitats

Lower South Bay is very rich in plant life, the majority of the species being abundant. In most of the habitats the plants grow in such a manner as to form dense masses, resembling, in miniature, the heavy forests of the land areas. The aquatic vegetation, which alone is here considered, is of two types, emergent and submerged, the former usually bordering the shore while the latter extends into the deeper water. No attempt was made to study the flora exhaustively, only the plants immediately associated with the animal habitats and the conspicuous plants of the shore margin were collected or noted.

The vegetation may be considered under five heads, arranged according to the character of the habitat. 1, low, swampy shores, well protected, mud bottom; 2, low shores partly protected, clay or sand bottom; 3, pond-like areas; 4, sandy or rocky, exposed shores; and 5, the submerged habitats.

**1. Low, Swampy Shores, well Protected.** This type of habitat contains such plants as Black Willow and Buttonbush which live on the shore, and Cat-tails, American Bulrush, Bur-reed, Arrow-heads, Pickerel-weed, Duck-weeds, and Loosestrife,* which occupy the shallow water bordering the shore vegetation. A few species of submerged plants, such as *Elodea, Najas, Myriophyllum,* and the Pond-weeds *Potamoge-*

* The scientific names of these plants will be found in the list of species at the end of this chapter.

Fig. 15. Lagoon east of the steamboat landing, Lower South Bay, looking up the lagoon from Habitat No. cxv. The shore is lined with a heavy growth of Lake Bulrush.

*ton natans, richardsonii, perfoliatus, interruptus,* and *robbinsii* are also present. Such habitats occur in the west end of Short Point Bay, on the south shore of Lower South Bay, and at the extreme southeast corner of the bay, east of the steamboat landing (see the vegetation maps, figures 18 and 19).

2. **Low Shores, partly Protected, with Clay or Sand Bottom.** Such habitats occur on the south shore of Long Point, south shore of Short Point, and in the southeast and south part of Lower South Bay. There is no sharp line between types 1 and 2, the latter habitat, however, not having the Buttonbush, Loosestrife, or Black Willow on the shore. There may be Cat-tails, Arrow-heads, Pickerel-weed, Bur-reed, American or Lake Bulrush, and a few Water Willow bordering the shore and extending to water three to four feet deep. Such submergent plants as *Elodea, Vallisneria, Myriophyllum,* and the Pond-weeds *Potamogeton lucens, perfoliatus, richardsonii, robbinsii,* and *interruptus* may also be present.

3. **Pond-like Areas.** In the shallow coves and bays on the south shore of Short Point Bay, the south shore of Short Point, in Short Point Bay, and along the south shore of Lower South Bay, where the bottom is more or less of mud and the area is protected to some extent from the rough water, habitats are formed which resemble those of ponds, and are characterized by the presence of *Castalia, Nymphæa, Potamogeton natans, perfoliatus, richardsonii, robbinsii,* and *interruptus, Elodea, Vallisneria, Utricularia, Lemna, Najas,* and *Chara.* Such places are favorite haunts for fish, where food is abundant. (See the maps, figures 18 and 19.)

4. **Sandy or Rocky, Exposed Shores.** In these habitats, which are either on exposed points or on shores subject to the full force of the wind and waves, the vegetation is confined to a few species, which, however, grow in great profusion. At the end of rocky points, like that at the end of Long Point and on Short Point, the Water Willow is very abundant, growing in heavy masses, usually in groups or "islands" of greater or less size. With the Water Willow is usually found the Lake

FIG. 16. Oneida Lake from Becker's Landing looking east. The plants in the water are Water Willow, Habitat No. cxliii.

Bulrush and bordering the shore sometimes Smith's Bulrush. On the rocky shore of the lake from Norcross Point eastward the same condition prevails (see vegetation map, fig. 20). On sandy, exposed shores, as at the west and east ends of the bay, the Lake Bulrush and the Water Willow, with a few submerged species like *Elodea, Potamogeten interruptus* and *richardsonii,* grow more or less abundantly.

**5. Submerged Vegetation.** The greater part of the bay is filled with vegetation belonging to the submerged type. Among these the Pond-weeds, *Potamogeton,* are the most abundant in both species and individuals. Nine species are represented in the collections, *foliosus, friesii, interruptus, lucens, perfoliatus, prælongus, richardsonii, robbinsii,* and *zosterifolius. Vallisneria, Elodea, Najas, Eleocharis, Chara, Nitella* and two species of *Myriophyllum, verticillatum* and *scabratum* also occur abundantly. The last group of plants forms vast subaqueous forests in Lower South Bay, especially in the south part. The submerged type of plants cover the bottom of Lower South and Short Point Bay (see maps, figs. 18 and 19).

Some idea of the abundance of the vegetation of Lower South Bay may be obtained by the data given in the chapter on quantitative values, brief mention of which is here made. These data show that on an average nine plants occur in an area of 64 square inches (about 400 square cm.), the number in the unit areas examined ranging from one to 27. If this average holds good for the entire territory within the 12-foot contour, where there are 25,550,444 square feet, there are upwards of 517,255,866 plants belonging to the submerged type within the area bordering the shore.

When it is remembered that each plant harbors a host of animals (mollusks, crustaceans, worms, insects, etc.) it is at once apparent that this abundant plant life forms a primary food supply of great value. A sandy clay or clay bottom produced the largest number of plants per unit area (64 square inches) ; the maximum amounts being on clay bottom 27 plants of six species; sandy clay bottom 26 plants of five species; and sand bottom 17 plants of two species. The greatest num-

FIG. 17. Shore of Oneida Lake looking west from Becker's Landing, Habitat No. cxliii. The plants in the water are American Bulrush and Water Willow.

ber of plants also occurred in moderately shallow water, from two to four feet deep.

It is interesting to note that the greater number of species as well as of individuals, occurred within the 6-foot contour. It is to be noted that the same is true of the animal population. Thirty-three species of plants were recorded from this area, of which 22 were submerged and 11 emergent species. Between the 6-foot and 12-foot contours 13 species have been observed, of which 12 were submerged and but one, *Scirpus occidentalis,* emergent. Beyond the 12-foot contour there are but few records, the only species noted being the Wild Celery or Eel Grass (*Vallisneria*), which was dredged from a depth of 14 feet near the entrance to the bay (Habitat No. clxi). It is probable that below 12 feet the gross vegetation is scanty or wanting. This fact is noted by Pieters ('01) in Lake St. Clair, who states that little or no vegetation flourishes below this depth. In Lake Erie the same author ('94, p. 15) observed that the plants disappeared when the water reached a depth of 15 feet, and were already scarce in water 10 feet deep.

In deep lakes the vegetation may descend on the slope of the subaqueous terraces to greater depths, Reighard ('15, p. 222) indicating a limit of 25 feet in Douglas Lake, Michigan. Davis ('08, p. 219) also limits plant life in Walnut Lake to a depth of 25 or 30 feet. Ekman ('15, pp. 160–162) records *Chara* at a depth of 120 meters (about 131 feet) in the Swedish Lake Vätter, but the majority of the species of plants were found in water not exceeding 16 meters (17½ feet) deep.

The zonal arrangement of plants is not a striking feature of the vegetation of Lower South Bay. In the majority of habitats the species grow in a mixed mass with no evident arrangement of species, and some of the species grow in colonies of greater or less size. Such colonies, consisting of *Elodea,* some *Potamogeton, Vallisneria, Myriophyllum, Pontederia,* and *Sagittaria* were noted in many places along the shore. In a few habitats in Short Point Bay and in the west and southwest side of Lower South Bay a zonal arrangement was observed, which was usually as follows:

*Shore.* Buttonbush, Black Willow.

*Edge of shore.* Loosestrife, Bur-reed, Cat-tail.

*10–30 feet from shore, water 1 to 3 feet deep.* Pickerel-weed, Arrowhead, American Bulrush, White Pond Lily, Yellow Pond Lily, *Potamogeton natans.*

*30–100 feet from shore, water 3 to 6 feet deep.* Lake Bulrush, Wild Celery, Water Weed (*Elodea*), *Myriophyllum, Potamogeton perfoliatus* and *richardsonii.*

The vegetation maps (figures 18, 19 and 20) indicate in a graphic manner the general distribution of the plants of this territory. A comparison of these with the large map detailing the physical characteristics of the lake and bay will serve to show the general ecological arrangement of plant life.

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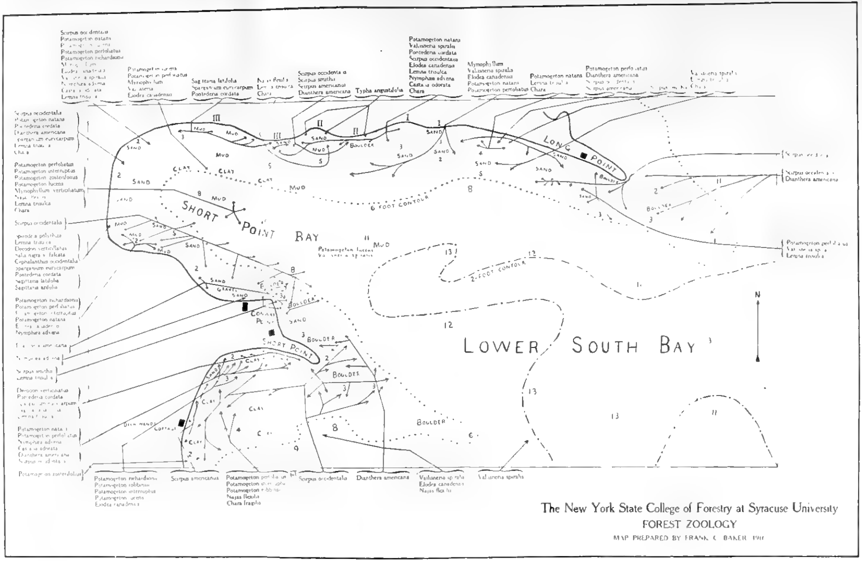


FIG. 18 Map of the gross vegetation in Short Point Bay and vicinity. The arrows point to the spot or spots where the vegetation enclosed by the bracket was observed. The depth of the water and the character of bottom material is also indicated. These maps (figures 18, 19, 20) should be compared with the larger map (fig. 1) for the position of the different habitats.

## Description of the Habitats and Their Gross Vegetation

The territory examined may be divided into four divisions: 1, Dunham Island and vicinity; 2, Lower South Bay; 3, south shore of the lake east of Norcross Point; and 4, certain localities at a distance from the Lower South Bay region. The latter are not included in the quantitative tables. The first three divisions are plotted on the large map (fig. 1) which should be consulted in connection with the habitat descriptions. The animal life and the algæ of each habitat are listed in the tables accompanying the chapter on Composition of the Bottom Fauna. These have been rearranged, averaged, and listed under the heading of the bottom material. Only living animals have been considered in preparing the quantitative tables. In the tables accompanying this chapter the higher plants are listed under each habitat together with the physical information necessary for an understanding of the environments. The methods of collecting the material are described in the Introductory Chapter.

### 1. Dunham Island

Dunham Island is about seven-eighths of a mile northeast of Norcross Point. It is three-eighths of a mile long and one-eighth of a mile wide and is pointed rather sharply at both ends. It is well wooded and the land rises 20 feet above the water surface in two places (380- and 390-foot contours, the surface of the lake being 369 feet above tide). On the west and south sides the water rapidly deepens to ten feet but on the north and east sides the water is shallow, ranging from one to five feet. Between Dunham and Frenchman Islands there is a sandy shoal, in most places less than five feet in depth, which is inhabited by a greater average number of animals than any region examined in the lake. Collections were made only at the west end of Dunham Island (fig. 5). The water here varies from one to five feet in depth and the bottom is of sand. The edge of the shore for a width of five or six feet is thickly strewn with boulders which are covered with a heavy growth of filamentous algæ. The sand is hard and well smoothed.

North of Dunham Island (200 or 300 feet) there is an extensive shoal about a fourth of a mile in length and upwards of 200 feet in width, the water ranging from one to three feet in depth, dropping, at the west end, to four and six feet and at the east end, from two to five feet. This shoal is very bouldery, the rocks ranging in size from 3 x 2 to 20 x 25 inches. The substratum upon which the boulders rest is firm sand with some gravel. Table No. 1 indicates the relations of the habitats near Dunham Island.

TABLE NO. 1. DUNHAM ISLAND HABITATS

| | | | | | |
|---|---|---|---|---|---|
| Habitat number | i | ii | iii | iv | v |
| Distance from shore (feet) | 5–6 | 6 | 5–30 | 50 | 300 |
| Depth of water (feet) | ½–1 | 2 | 1½–4 | 5 | 1–3 |
| Character of bottom | bould. | sand gravel | sand | old log | bould. |
| Unit area (square inches) | 32 | 16 | 16 | 100 | 6x7 4x5 |
| Field numbers | 701 | 700 | 702 705–7 802 | 708 | 703 704 |
| Date (July) | 11 | 11 | 11 | 11 | 11 |
| Fig. of material | ..... | ..... | ..... | 42 | 43 |
| *Dianthera americana* | ..... | ..... | x | ..... | x |
| *Myriophyllum verticillatum* | ..... | ..... | ..... | ..... | x |
| *Lemna trisulca* | x | ..... | ..... | ..... | ..... |

## 2. LOWER SOUTH BAY

The area included under this head embraces all of the body of water enclosed by a line drawn eastward from Long Point meeting a line drawn northward from Norcross Point, a total area of 881 acres. This territory is divisible into several smaller areas (see the map, fig. 1).

1. **Long Point.** This (figs. 6, 7) is a narrow body of land (see the chapter on Topography). The shores are low and there is a heavy growth of vegetation. The bottom areas are sandy or bouldery, the latter condition prevailing at the

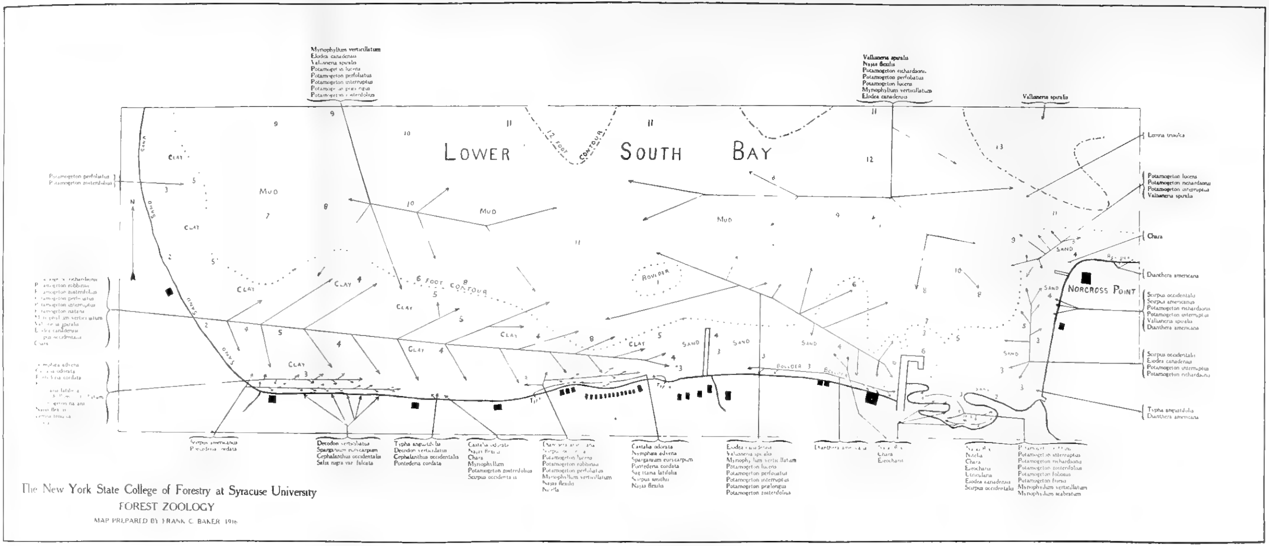


FIG. 19. Map of the distribution of the gross vegetation in the lower part of Lower South Bay. Figures 18 and 19 are drawn to the same scale and may be used as a single map

end of the point, the sand areas being several hundred feet west of the end of the point. One of the largest boulder areas extends from the end of the point into the lake for the distance of 600 or more feet. The south side of Long Point, especially that portion bordering the north shore of Short Point Bay, is marked by three rounded points and three bays. The bottom material of these areas is of gravel, sand, boulders, and mud, the latter being more abundant in the bay at the west end of Short Point Bay. The water on the points as well as in the bays is shallow for a considerable distance from shore. Filamentous algæ of several species is abundant over much of the bottom and frequently quite conceals the real character of the bottom material. Table No. 2 indicates the nature of the several habitats.

TABLE NO. 2. LONG POINT HABITATS

| Habitat numbers | vi | vii | viii | ix | x | xi | xii | xiii | xiv | xv | xvi | xvii | xviii | xix | xxi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Field numbers | 744–746 | 760 | 751–3 854 | 747–750 | 761–762 | 754–759 | 763–767 | 858 | 768–772 | 773–774 | 775–778 | 780–783 | 784–788 | 853 | 790–792 |
| Distance from shore (feet) | 50 | 50–100 | 50 | 100 | 5 | 100 | 50 | 10 | 125 | 25 | 25 | 50 | 50 | 50 | 40 |
| Depth of water (feet) | 2½ | 2–3 | 3 | 4 | 1–1½ | 4½ | 3½ | 1½ | 4½ | 4 | 1–2½ | 3 | 3 | 2½ | 4 |
| Character of bottom | bould. | sand bould. | bould. | sand | bould. | sand | sand | sand | mud | mud | sand | sand | sand | sand | mud |
| Unit area (square inches) | .... | 64 | 64 | 16 | 3x4½ | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | sq.yd. | 16 |
| Fig of material collected | .... | .... | .... | .... | .... | ... | 25 | ... | ... | ... | ... | ... | ... | ... | .... |
| Date (July) | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 18 | 14 | 14 | 14 | 14 | 14 | 17 | 14 |
| *Castalia odorata* | .... | .... | .... | .... | .... | ... | ... | ... | ... | ... | ... | ... | ... | ... | .... |
| *Dianthera americana* | .... | .... | .... | .... | .... | ... | ... | ... | ... | ... | ... | ... | ... | ... | x |
| *Elodea canadensis* | .... | .... | .... | .... | .... | ... | x | x | ... | ... | x | x | x | ... | .... |
| *Lemna trisulca* | .... | .... | .... | .... | .... | ... | ... | ... | ... | ... | ... | ... | ... | x | x |
| *Myriophyllum verticillatum* | .... | .... | .... | x | .... | x | ... | ... | ... | ... | ... | x | ... | ... | x |
| *Nymphæa advena* | .... | .... | .... | .... | .... | ... | ... | ... | ... | ... | ... | ... | ... | x | .... |
| *Pontederia cordata* | .... | .... | .... | .... | .... | ... | ... | ... | ... | ... | ... | ... | ... | ... | x |
| *Potamogeton natans* | .... | .... | .... | .... | .... | ... | ... | ... | ... | x | ... | ... | x | ... | x |
| *Potamogeton perfoliatus* | .... | .... | .... | x | .... | ... | x | ... | x | ... | ... | x | x | x | x |
| *Scirpus americanus* | .... | .... | .... | .... | .... | ... | x | x | ... | ... | x | x | ... | ... | .... |
| *Scirpus occidentalis* | x | x | x | .... | .... | ... | x | ... | ... | ... | ... | ... | x | ... | x |
| *Scirpus smithii* | .... | .... | .... | .... | .... | ... | ... | ... | ... | ... | x | x | ... | ... | .... |
| *Vallisneria spiralis* | .... | .... | .... | x | .... | x | x | ... | x | ... | ... | ... | ... | ... | x |

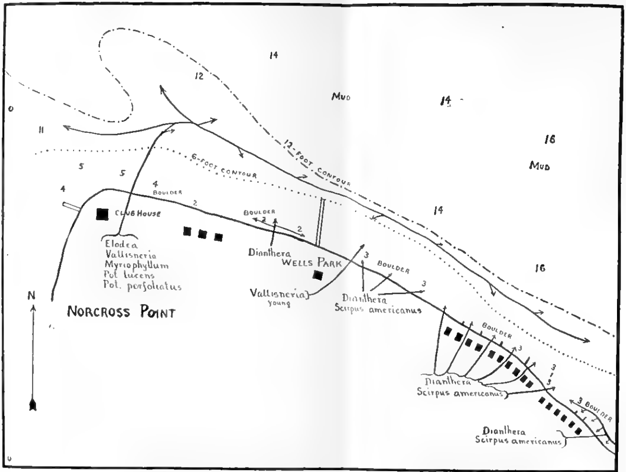


Fig. 20 Map of the distribution of the gross vegetation along the shore of Oneida Lake east of Norcross Point

**2. Short Point Bay.** The second rounded point west of Long Point marks the entrance to Short Point Bay as Short Point marks the entrance on the south side. The bay (fig. 8) is about a third of a mile long and a quarter of a mile wide and covers an area of about 53 acres. The north shore, bordering the peninsula known as Long Point, is bouldery on the points and sandy or muddy in the bays, the third bay near the extreme west end of Short Point Bay having a typical mud bottom. The head of the bay has a hard sand bottom and is without vegetation. The south side has a soft black mud bottom at the southwest side which changes to clay and then to sand as Conway Point is approached. The water shallows gradually from shore to the 6-foot contour. Vegetation is represented by few species on the north side of the bay, a much larger number occurring in the mud bottom area at the southwest corner of the bay. The bottom of the whole area is more or less covered with debris consisting of plant fragments, pieces of wood, dead, bleached molluscan shells, empty caddis-fly and chironomid larval tubes, etc. In many places there is a heavy growth of filamentous algæ. Table No. 3 shows the habitats of Short Point Bay. Habitat No. xxxvi is characteristic of a typical protected habitat. The shore is swampy and the water extends well into the wooded area, which consists of Black Willow (*Salix nigra falcata*) and Buttonbush (*Cephalanthus occidentalis*). The water bordering the shore is from six to 20 inches deep and the shore is lined with Swamp Loosestrife (*Decodon verticillatus*), Burreed (*Sparganium eurycarpum*), Pickerel-weed (*Pontederia cordata*), Arrow-heads (*Sagittaria arifolia* and *A. latifolia*) and the Yellow Water Lily (*Nymphæa advena*). The bottom near the shore is of black mud covered with fragments of plants and pieces of wood, and also a thick, fluffy substance evidently decaying plant material (detritus). A heavy blanket of filamentous algæ covers everything, the bottom and the vegetation to the surface of the water.

TABLE NO. 3. SHORT POINT BAY HABITATS

| Habitat numbers | xxi | xxii | xxiii | xxiv | xxv | xxvi | xxvii | xxviii | xxix | xxx | xxxi | xxxii | xxxiii | xxxiv | xxxv | xxxvi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Field numbers | 804–807 | 793–4 852 | 803 | 799–800 | 808–810 | 811–814 | 795–798 | 815–818 | 819 | 820–823 | 824–826 | 827–831 | 836–841 | 842–843 | 1051 | 832–835 |
| Distance from shore (feet) | 25–50 | 100 | 30 | 150 | 50 | 40 | 30 | 30 | 40 | 25 | 50 | 25 | 50 | 5–10 | 250 | 2–10 |
| Depth of water (feet) | $2\frac{1}{2}$–$3\frac{1}{2}$ | $2\frac{1}{4}$ | $3\frac{1}{2}$ | $5\frac{1}{2}$ | $2\frac{1}{2}$–$3\frac{1}{2}$ | 3 | 3 | $3\frac{1}{2}$ | $2\frac{1}{2}$ | 3 | 4 | 2 | $3\frac{1}{3}$ | $1\frac{1}{2}$ | 4 | 1–3 |
| Character of bottom | bould. | gravl. | sand | mud | sand | sand | sand | mud | mud | sand | sand | sand | sand | sand | sand | mud |
| Unit area (sq. in.) | 4x3x$2\frac{1}{2}$ 4x4x$3\frac{1}{2}$ 3x$2\frac{1}{2}$x2 4x4x$2\frac{1}{2}$ | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| Fig. of material collected | ..... | 24 | ... | ... | 26 | ... | 27 | ... | ... | ... | ... | ... | ... | ... | 28 | 35 |
| Date (July) | 14 | 14 | 17 | 14 | 17 | 17 | 14 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 27 | 17 |
| *Castalia odorata* | ..... | ... | x | ... | x | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | .... |
| *Decodon verticillatus* | ..... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | x |
| *Dianthera americana* | x | x | ... | ... | x | ... | ... | ... | ... | x | ... | ... | ... | ... | ... | .... |
| *Elodea canadensis* | ..... | ... | x | ... | ... | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | x |
| *Lemna trisulca* | ..... | ... | x | ... | ... | ... | x | ... | x | ... | x | ... | ... | ... | ... | x |
| *Najas flexilis* | ..... | x | ... | x | ... | x | x | ... | ... | ... | ... | ... | ... | ... | x | .... |
| *Nymphæa advena* | ..... | ... | x | ... | x | x | ... | x | ... | ... | ... | ... | ... | ... | ... | .... |
| *Pontederia cordata* | ..... | ... | x | ... | x | x | ... | ... | ... | x | ... | ... | ... | ... | ... | x |
| *Potamogeton interruptus* | ..... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | x |
| *Potamogeton lucens* | ..... | ... | ... | ... | ... | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | .... |
| *Potamogeton natans* | ..... | ... | x | ... | ... | ... | ... | x | ... | x | ... | ... | ... | ... | ... | x |
| *Potamogeton perfoliatus* | ..... | ... | ... | x | ... | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | x |
| *Potamogeton richardsonii* | ..... | ... | ... | ... | ... | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | x |
| *Sagittaria arifolia* | ..... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | x |
| *Sagittaria latifolia* | ..... | ... | ... | ... | ... | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | x |
| *Scirpus americanus* | ..... | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | .... |
| *Scirpus occidentalis* | x | x | x | x | ... | x | ... | x | ... | x | x | ... | x | ... | ... | x |
| *Scirpus smithii* | x | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | .... |
| *Sparganium eurycarpum* | ..... | ... | ... | ... | ... | ... | ... | ... | ... | x | ... | ... | ... | ... | ... | x |
| *Spirodela polyrhiza* | ..... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | x |
| *Vallisneria spiralis* | ..... | ... | x | x | ... | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | .... |

3. **Conway Point.** This piece of land extending into Short Point Bay in a northerly direction is apparently without a name, and at the suggestion of Mrs. F. C. Baker, it is here designated Conway Point, the name being that of a Syracuse gentleman who has a summer cottage near this point. The land rises in a northerly direction to a height of about eight feet above lake level and forms a small bluff. The bottom at the end of the point is bouldery with sand areas on the east and west sides. The water is a foot or two deep on the point and gradually deepens to six feet (Table 4).

4. **Short Point** (fig. 9). This is a low, tongue-shaped point of land separating Short Point Bay from Lower South Bay. It is about 300 feet long and 80 feet wide. The water surrounding the point is shallow and very bouldery, the stony area extending eastward into the larger body of water for several hundred feet. A shallow area less than six feet deep with sand or boulder bottom, extends southeasterly for a distance of nearly 1,500 feet (Table 5).

5. **Lower South Bay.** Under this head is included the larger part of the body of water known as Lower South Bay. In the west end of the bay between Short Point and the south shore of the bay, there is a narrow strip of sand bottom bordering the shore and not exceeding 50 feet in width. Beyond this sand area the bottom is composed of clay to the 6-foot contour where the mud bottom areas begin (Table No. 6). The vegetation varies greatly in different places in this territory. South and west of Short Point the shore is protected from rough water and plants are numerous in both species and individuals. The shore is lined with Cat-tails (*Typha angustifolia*) or American Bulrush (*Scirpus americanus*), with Loosestrife (*Decodon verticillatus*) in the more protected places (fig. 10). In deeper water the Lake Bulrush (*Scirpus occidentalis*), the Water Lilies (*Nymphæa* and *Castalia*) and a few submerged plants like *Potamogeton* occur (fig. 11).

TABLE NO. 4. CONWAY POINT HABITATS

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Habitat numbers | xxxvii | xxxviii | xxxix | xl | xli | xlii | xliii | xliv |
| Field numbers | 844–845 | 846–848 | 849 | 850–851 | 859 | 860–862 | 863 | 864–865 |
| Distance from shore | 300 | 100 | 50 | 50 | 200 | 100 | 50 | 125 |
| Depth of water (feet) | 6 | 3 | 3 | $2\frac{1}{2}$ | 6 | $3\frac{1}{2}$ | 3 | 3 |
| Character of bottom | sand | sand | gravel | gravel boulder | boulder | boulder | boulder | boulder |
| Unit area (sq. in.) | 16 | 16 | 16 | 16<br>5x5x3 | $5x2x3\frac{1}{2}$ | $3x2x1\frac{1}{2}$<br>$4x2x3\frac{1}{2}$<br>$4x3x1\frac{1}{2}$<br>$3x2x3\frac{1}{2}$ | $3\frac{1}{2}x2\frac{1}{2}x2$ | $3x3x\frac{1}{2}$<br>3x2x2 |
| Figure of bottom material | ...... | ...... | ...... | ...... | ...... | 21 | ...... | ...... |
| Date (July) | 17 | 17 | 17 | 17 | 19 | 19 | 19 | 19 |
| *Dianthera americana* | ...... | ...... | ...... | ...... | ...... | ...... | ...... | x |
| *Lemna trisulca* | ...... | ...... | ...... | ...... | ...... | ...... | x | ...... |
| *Nymphæa advena* | ...... | ...... | x | ...... | ...... | ...... | ...... | ...... |
| *Scirpus occidentalis* | x | ...... | ...... | x | x | x | x | x |
| *Scirpus smithii* | ...... | ...... | ...... | x | ...... | ...... | ...... | ...... |

TABLE No. 5. SHORT POINT HABITATS

| | | | | | | |
|---|---|---|---|---|---|---|
| Habitat numbers. | xlv | xlvi | xlvii | xlviii | xlix | l |
| Field numbers. | 866–869 | 871 | 872–875 | 876–878 | 879–881 | 882–884 |
| Distance from shore | 30 | 1–2 | 100 | 200 | 25 | 25 |
| Depth of water (feet) | $1\frac{1}{2}$ | $\frac{1}{2}$ | $2\frac{3}{4}$ | 3 | 3 | $2\frac{3}{4}$ |
| Character of bottom | boulder | bould. | gravel | gravel boulder | sand | sand |
| Unit area (sq. in.) | $6x3x4\frac{1}{2}$ $6x4\frac{1}{2}x2\frac{1}{2}$ $3x2x4\frac{1}{2}$ 11x10x6 | 6x5x4 | 16 | $3x3\frac{1}{2}x6\frac{1}{2}$ $4x3x2\frac{1}{2}$ $3x1x4\frac{1}{2}$ | 16 | 16 |
| Fig. of material. | 22 | .... | .... | 23 | .... | .... |
| Date (July) | 19 | 19 | 19 | 19 | 19 | 19 |
| *Castalia odorata* | ...... | .... | .... | ...... | x | x |
| *Dianthera americana* | ...... | .... | x | x | x | x |
| *Lemna trisulca* | ...... | .... | .... | ...... | .... | x |
| *Nymphæa advena* | ...... | .... | .... | ...... | x | x |
| *Pontederia cordata* | ...... | .... | .... | ...... | .... | x |
| *Potamogeton natans* | ...... | .... | .... | ...... | x | x |
| *Potamogeton perfoliatus* | ...... | .... | .... | ...... | x | x |
| *Scirpus occidentalis* | ...... | .... | .... | ...... | x | x |

The greater part of the area bordering the shore, however, is entirely free of vegetation (fig. 12), which does not appear until deeper water is reached, several hundred feet from the shore. The bottom in many places is covered with the usual debris of plant fragments, dead and bleached shells, worm cases, etc., and over all there is more or less algæ, both filamentous and the so-called "blue-green." This shore bottom is inclined to be of a marly character, *Chara fragilis* being very plentiful.

The south shore is abundantly supplied with vegetation, both specifically and individually (Table No. 6). The shore is lined with Willow (*Salix nigra falcata*), Buttonbush (*Cephalanthus occidentalis*), Loosestrife (*Decodon verticillatus*), and Cat-tail (*Typha angustifolia*) (fig. 13), and the shallow water bordering the shore has a heavy growth of Bur-reed (*Sparganium eurycarpum*), Pickerel-weed (*Pontederia cordata*), Arrow-heads (*Sagittaria latifolia* and *S. arifolia*), and American Bulrush (*Scirpus americanus*). Farther from shore there are colonies of greater or less extent of Water Lilies

(*Nymphæa* and *Castalia*), Pickerel-weed (*Pontederia* in bloom), and the Floating Pond-weed (*Potamogeton natans*). The Pond-weeds (*Potamogeton*), Water-weeds (*Elodea*), and Milfoil (*Myriophyllum*) are very abundant in water from three to six feet deep. The Lake Bulrush (*Scirpus occidentalis*) is common almost everywhere. The bottom is of clay, which in places almost becomes mud. The water is shallow for a great distance, the 6-foot contour being over 1,200 feet from shore in its maximum distance. Farther east, where the protection afforded by Long Point and Short Point is less effective, the bottom material is of clay mixed with fine sand covered more or less with organic debris and filamentous algæ (Tables Nos. 7, 8). The water deepens more rapidly than in the section farther west, discussed above. The vegetation is abundant and contains much the same species as mentioned previously. In the deeper water, *Myriophyllum, Elodea,* and *Potamogeton* are so thick that the mass resembles a miniature forest.

TABLE NO. 6. LOWER SOUTH BAY HABITATS. WEST SHORE

| Habitat numbers | li | lii | liii | liv | liv | lvi | lvii | lviii | lix | lx | lxi | lxii | lxiii | lxiv | lxv | lxvi | lxvii |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Field numbers | 911 | 885 | 886–888 | 894 895 | 910 | 889–893 | 896–898 | 899 | 912 | 908 909 | 900 | 901 | 902 903 | 955 | 904–913 | 905 | 906 907 |
| Distance from shore | 75 | 30 | 25 | 100 | 2 | 20 | 100 | 200 | 250 | 400 | 25 | 75 | 300 | 1–2 | 100 | 300 | 300 |
| Depth of water (feet) | 3 | 3 | $2\frac{1}{2}$–$3\frac{3}{4}$ | 3 | 2 | $1\frac{1}{2}$ | $3\frac{1}{2}$ | $4\frac{1}{2}$ | $4\frac{1}{2}$ | $5\frac{1}{2}$ | $1\frac{1}{2}$ | $2\frac{3}{4}$ | $3\frac{1}{2}$ | 1 | 2 | 5 | 5 |
| Character of bottom | clay | clay sand | sand clay | sand clay | clay | clay | clay | clay | clay | clay | sand | clay | clay | sand | clay | clay | clay |
| Unit area (sq. in.) | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| Date (July) | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 |
| *Castalia odorata* | ... | x | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| *Chara fragilis* | ... | ... | ... | ... | ... | ... | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | ... |
| *Dianthera americana* | x | x | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| *Elodea canadensis* | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| *Lemna trisulca* | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| *Najas flexilis* | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| *Nymphæa advena* | x | x | x | ... | ... | ... | ... | ... | x | x | ... | ... | ... | ... | ... | ... | ... |
| *Pontederia cordata* | ... | x | x | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| *Potamogeton interruptus* | ... | ... | x | ... | ... | ... | ... | x | x | ... | ... | ... | ... | ... | ... | ... | ... |
| *Potamogeton lucens* | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| *Potamogeton natans* | x | x | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| *Potamogeton perfoliatus* | x | x | x | ... | ... | ... | ... | x | x | ... | ... | ... | x | ... | ... | ... | ... |
| *Potamogeton richardsonii* | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| *Potamogeton robbinsii* | ... | ... | x | ... | ... | ... | ... | x | x | ... | ... | ... | ... | ... | ... | ... | ... |
| *Potamogeton zosterifolius* | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | x | x | ... | ... | ... | ... |
| *Sagittaria arifolia* | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| *Scirpus americanus* | ... | ... | ... | ... | ... | x | ... | ... | ... | ... | x | ... | ... | ... | ... | ... | ... |
| *Scirpus occidentalis* | x | x | x | x | ... | ... | x | ... | ... | ... | ... | x | ... | ... | ... | ... | ... |
| *Sparganium eurycarpum* | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| *Typha angustifolia* | ... | ... | ... | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |

3

## Table No. 7. Lower South Bay Habitats. West End, South Side

| Habitat numbers | lxviii | lxix | lxx | lxxi | lxxii | lxxiii | lxxiv | lxxv | lxxvi | lxxvii | lxxviii | lxxix | lxxx | lxxxi | lxxxii | lxxxiii |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Field numbers | 915 | 916 | 917 | 918<br>919 | 920 | 922 | 921 | 923 | 924<br>925 | 926<br>927 | 928 | 929–<br>931 | 932–<br>934 | 935<br>936 | 937 | 938 |
| Distance from shore | 20 | 50 | 100 | 200 | 500 | 300 | 20 | 300 | 800 | 75 | 200 | 400 | 600 | 700 | 500 | 100 |
| Depth of water (feet) | $1\frac{1}{3}$ | 2 | $3\frac{1}{2}$ | 4 | 5 | 4 | $1\frac{1}{2}$ | $4\frac{1}{3}$ | 5 | 2 | 3 | 4 | 5 | $5\frac{1}{2}$ | 5 | $2\frac{1}{2}$ |
| Character of bottom | sand | sand | clay | clay | clay | clay | clay | clay | clay | clay | clay | clay | clay | clay | clay | clay |
| Unit area (sq. in.) | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| Fig. of material | ... | ... | ... | 31 | ... | ... | ... | 32 | ... | ... | ... | ... | ... | ... | ... | ... |
| Date (July) | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| *Castalia odorata* | ... | x | ... | x | ... | x | ... | ... | ... | ... | x | ... | ... | ... | ... | ... |
| *Decodon verticillatus* | ... | ... | ... | ... | ... | ... | ... | ... | ... | x | ... | ... | ... | ... | ... | x |
| *Eleocharis acicularis* | ... | x | x | x | ... | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | ... |
| *Elodea canadensis* | ... | x | ... | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| *Lemna trisulca* | ... | x | x | x | ... | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | ... |
| *Myriophyllum verticillatum* | ... | ... | x | x | ... | ... | ... | x | x | x | x | x | x | x | x | x |
| *Najas flexilis* | ... | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | x |
| *Nymphæa advena* | ... | x | ... | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | x |
| *Pontederia cordata* | x | x | x | ... | ... | x | ... | ... | ... | x | x | ... | ... | ... | ... | x |
| *Potamogeton interruptus* | ... | x | x | ... | ... | ... | x | x | ... | ... | ... | ... | ... | ... | ... | ... |
| *Potamogeton lucens* | ... | ... | ... | ... | ... | ... | ... | ... | x | ... | ... | ... | ... | ... | ... | ... |
| *Potamogeton natans* | ... | x | ... | ... | ... | x | ... | ... | ... | ... | x | ... | ... | ... | ... | ... |
| *Potamogeton perfoliatus* | ... | x | ... | ... | ... | ... | ... | x | x | ... | ... | x | ... | x | x | ... |
| *Potamogeton robinsii* | ... | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| *Potamogeton zosterifolius* | ... | ... | ... | ... | ... | ... | ... | x | ... | ... | ... | ... | ... | x | x | x |
| *Sagittaria arifolia* | ... | ... | ... | ... | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| *Scirpus americanus* | x | ... | ... | ... | ... | ... | x | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| *Scirpus occidentalis* | x | x | x | x | x | x | ... | x | x | x | x | x | x | x | x | x |
| *Sparganium eurycarpum* | ... | ... | ... | ... | ... | ... | ... | ... | ... | x | ... | ... | ... | ... | ... | ... |
| *Typha angustifolia* | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | x |
| *Vallisneria spiralis* | ... | x | x | ... | ... | ... | ... | ... | ... | ... | ... | ... | x | ... | ... | x |

TABLE NO. 8. LOWER SOUTH BAY HABITATS. MIDDLE SECTION, SOUTH SHORE

| Habitat numbers | lxxxiv | lxxxv | lxxxvi | lxxxvii | lxxxviii | lxxxix | xc | xci | xc | xciii | xciv | xcv | xcvi | xcvii |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Field numbers | 939–941 | 942 943 | 969 970 | 966 967 | 965 | 944–947 | 948–952 | 971–973 | 956 | 957–959 | 962 | 960 961 | 963 964 | 974 975 |
| Distance from shore | 400 | 200 | 75 | 25 | 100 | 50 | 200 | 200 | 300 | 200 | 300 | 250 | 100 | 200 |
| Depth of water (feet) | 4 | 3 | 3 | 1½ | 3 | 2 | 3½ | 4 | 5 | 3½ | 5 | 4 | 4 | 3 |
| Character of bottom | clay | clay | sand-clay | sand-clay | sand-clay | sand-clay | sand-clay | sand-clay | sand-clay | sand-clay | sand-clay | sand-clay | sand-clay | sand |
| Unit area (sq. in.) | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| Fig. of material | .... | .... | .... | .... | .... | .... | .... | .... | .... | 34 | .... | .... | .... | 29 |
| Date (July) | 20 | 20 | 22 | 22 | 22 | 20 | 20 | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| *Castalia odorata* | .... | .... | x | x | .... | x | x | .... | .... | .... | .... | .... | .... | .... |
| *Dianthera americana* | x | .... | .... | .... | .... | x | .... | .... | .... | x | .... | x | .... | .... |
| *Elodea canadensis* | .... | .... | .... | x | .... | .... | x | .... | .... | .... | .... | .... | .... | .... |
| *Myriophyllum verticillatum* | x | x | x | x | x | x | x | x | x | x | x | x | x | .... |
| *Najas flexilis* | .... | x | .... | .... | .... | x | .... | .... | .... | .... | .... | .... | .... | .... |
| *Nymphæa advena* | .... | .... | x | x | .... | x | .... | .... | .... | .... | .... | .... | .... | .... |
| *Nitella* | .... | .... | .... | .... | .... | .... | .... | x | .... | .... | .... | .... | .... | .... |
| *Pontederia cordata* | .... | .... | .... | x | .... | x | .... | .... | .... | .... | .... | .... | .... | .... |
| *Potamogeton interruptus* | .... | .... | .... | .... | .... | .... | .... | .... | .... | x | .... | .... | x | .... |
| *Potamogeton lucens* | x | x | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| *Potamogeton natans* | .... | .... | .... | .... | x | .... | x | .... | .... | x | .... | x | x | .... |
| *Potamogeton perfoliatus* | x | x | x | .... | .... | .... | x | x | x | x | .... | .... | x | .... |
| *Potamogeton richardsonii* | .... | .... | .... | .... | .... | .... | x | x | x | x | .... | .... | .... | .... |
| *Potamogeton robbinsii* | .... | .... | x | x | x | .... | x | .... | .... | .... | x | .... | x | .... |
| *Potamogeton zosterifolius* | .... | .... | .... | .... | .... | .... | x | .... | .... | .... | .... | x | x | .... |
| *Sagittaria latifolia* | .... | .... | .... | x | .... | x | .... | .... | .... | .... | .... | .... | .... | .... |
| *Scirpus americanus* | .... | .... | .... | x | .... | .... | .... | .... | .... | x | .... | .... | .... | .... |
| *Scirpus occidentalis* | x | x | .... | .... | .... | x | x | x | .... | x | .... | .... | .... | .... |
| *Scirpus smithii* | .... | .... | .... | x | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| *Sparganium eurycarpum* | .... | .... | .... | x | .... | x | .... | .... | .... | .... | .... | .... | .... | .... |
| *Typha angustifolia* | .... | .... | .... | .... | .... | x | .... | .... | .... | .... | .... | .... | .... | .... |
| *Vallisneria spiralis* | .... | .... | .... | .... | .... | .... | x | .... | .... | x | x | .... | x | .... |

TABLE NO. 9. LOWER SOUTH BAY HABITATS. EAST OF THIERRE'S LANDING

| Habitat numbers | xcviii | xcix | c | ci | cii | ciii | civ | cv | cxvii | cxviii | cxix |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Field numbers | 976<br>977 | 978 | 979<br>980 | 981–<br>983 | 984<br>985 | 986<br>987 | 988–<br>990 | 968 | 1012 | 1013 | 1014 |
| Distance from shore | 400 | 200 | 150 | 200 | 300 | 100 | 250 | 400 | 20 | 50 | 100 |
| Depth of water (feet) | 4 | 3 | 3 | 3 | 4 | 3 | 6 | 6 | 3 | 3 | 2 |
| Character of bottom | sand | sand | sand<br>gravel | gravel | sand | gravel<br>b ld. | sand<br>gravel | sand–<br>clay | gravel<br>bould. | sand | sand |
| Unit area (sq. in.) | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| Fig. of material | .... | ... | .... | .... | 30 | .... | .... | .... | .... | .... | .... |
| Date (July) | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 24 | 24 | 24 |
| *Dianthera americana* | .... | .... | .... | .... | .... | x | .... | .... | .... | .... | .... |
| *Elodea canadensis* | .... | .... | .... | .... | .... | .... | x | .... | .... | .... | .... |
| *Eleocharis acicularis* | .... | .... | .... | x | .... | .... | .... | .... | .... | .... | .... |
| *Najas flexilis* | .... | .... | .... | x | .... | .... | .... | .... | .... | .... | .... |
| *Myriophyllum verticillatum* | .... | .... | .... | .... | .... | .... | x | .... | .... | .... | .... |
| *Potamogeton interruptus* | .... | .... | .... | .... | .... | .... | x | .... | x | .... | x |
| *Potamogeton lucens* | .... | .... | .... | .... | .... | .... | x | .... | .... | .... | .... |
| *Potamogeton perfoliatus* | .... | .... | .... | .... | .... | .... | x | x | .... | .... | .... |
| *Potamogeton praelongus* | .... | .... | .... | .... | .... | .... | x | .... | .... | .... | .... |
| *Potamogeton richardsonii* | .... | .... | .... | .... | .... | .... | .... | x | x | .... | x |
| *Potamogeton zosterifolius* | .... | .... | .... | .... | .... | .... | x | x | .... | .... | .... |
| *Scirpus americanus* | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| *Scirpus occidentalis* | .... | .... | .... | .... | .... | .... | .... | .... | .... | x | .... |
| *Vallisneria spiralis* | .... | .... | .... | .... | .... | .... | x | .... | .... | .... | .... |

TABLE NO. 9. LOWER SOUTH BAY HABITATS. EAST OF THIERRE'S LANDING—*Concluded*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Habitat numbers | cxx | cxxi | cxxii | cxxiii | cxxiv | cxxv | cxxvi | cxxvii | cxxviii | cxxix |
| Field numbers | 1015 | 1016 1017 | 1018 | 1019 | 1020–1021 | 1022 | 1023 1035 | 1026 | 1024 | 1025 |
| Distance from shore | 200 | 400 | 300 | 150 | 30 | 50 | 25 | 150 | 200 | 100 |
| Depth of water (feet) | 3 | 3½ | 6 | 3 | 2 | 4½ | 3 | 4 | 5½ | 4 |
| Character of bottom | sand | sand | sand | sand | sand | sand | sand | sand | sand | sand |
| Unit area (sq. in.) | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| Fig, of material | .... | .... | .... | .... | .... | .... | .... | .... | .... | ..... |
| Date (July) | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| *Dianthera americana* | .... | .... | .... | x | .... | .... | .... | .... | .... | ..... |
| *Elodea canadensis* | .... | x | .... | .... | .... | .... | .... | .... | .... | ..... |
| *Eleocharis acicularis* | .... | .... | .... | .... | .... | .... | .... | .... | .... | ..... |
| *Najas flexilis* | .... | .... | .... | .... | .... | .... | .... | .... | .... | ..... |
| *Myriophyllum verticillatum* | .... | .... | .... | .... | .... | .... | .... | .... | .... | ..... |
| *Potamogeton interruptus* | .... | .... | .... | x | x | x | x | x | x | ..... |
| *Potamogeton lucens* | .... | .... | .... | .... | .... | x | x | x | x | ..... |
| *Potamogeton perfoliatus* | .... | .... | .... | .... | .... | .... | .... | .... | .... | ..... |
| *Potamogeton praelongus* | .... | .... | .... | .... | .... | .... | .... | .... | .... | ..... |
| *Potamogeton richardsonii* | .... | .... | x | x | x | x | x | x | x | ..... |
| *Potamogeton zosterifolius* | .... | .... | .... | .... | .... | .... | .... | .... | .... | ..... |
| *Scirpus americanus* | .... | .... | .... | x | x | .... | .... | .... | .... | ..... |
| *Scirpus occidentalis* | x | x | x | x | x | .... | .... | .... | .... | ..... |
| *Vallisneria spiralis* | .... | .... | .... | x | x | x | .... | x | x | ..... |

East of Thierre's landing to Norcross Point, including the steamboat wharf at South Bay (fig. 14), the bottom is of hard sand and the vegetation is reduced to comparatively few species, among which Bulrush (*Scirpus*) and Water Willow (*Dianthera*) predominate, bordering the shore. In the deeper water the plants become more numerous, and include the Lake Bulrush (*Scirpus occidentalis*), several *Potamogeton, Myriophyllum,* and *Elodea.* Between Thierre's landing and the steamboat wharf there is an area of bottom which is very bouldery, the water being from two to three feet deep. The depth increases gradually in this area from a foot or more to the 6-foot contour.

Between the steamboat wharf and the Norcross Point shore there are two lagoons which exhibit a variety of habitat conditions (fig. 15). These are separated from the lake or bay by three small points of land, or peninsulas, which protect these bodies of water from the rough water incident to northwest storms. The peninsulas have a sand, gravel, and boulder bottom on the north or exposed sides and the water is shallow northward for a considerable distance. On the south or protected sides of these points of land the bottom is of fine sand, clay or mud and the water rapidly deepens to five and six feet. Vegetation is very luxuriant, *Typha angustifolia, Scirpus americanus,* and *Scirpus occidentalis* bordering the shore and a large number of submerged plants filling the water to such an extent that it is difficult to push a boat through them. Among these, *Potamogeton* is conspicuous both in number of species and in individual plants. The surface of the water is thickly covered with a growth of filamentous algæ, *Cladophora* and *Œdogonium* (Table No. 10).

**6. The Deeper Water Habitats of Lower South Bay.** Beyond the 6-foot contour, the depth of water gradually increases toward the east until it attains 15 feet at the entrance to the bay. The bottom material is black mud, usually soft and covered with organic debris and some algæ. Off the points there is often an admixture of gravel. Vegetation is all of the submerged type and is in most places very abundant, forming a mass of plants, *Potamogeton* and *Myriophyllum* being the

TABLE NO. 10. LAGOON HABITATS EAST OF THE STEAMBOAT WHARF, LOWER SOUTH BAY

| Habitat numbers | cvi | cvii | cviii | cix | cx | cxi | cxii | cxiii | cxiv | cvx | cxvi |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Field numbers | 1002 | 1001 1000 | 999 | 1003 | 993–997 | 998 | 1004 | 1005–1007 | 1009–1010 | 1008 | 1011 |
| Distance from shore | 50 | 5–30 | 5 | 100 | 10 | 5 | 5 | 20 | 6 | 50 | 50 |
| Depth of water (in feet) | 1 | 1–2½ | 3 | 1½ | 4 | ⅓ | 1½ | 2½ | 1½ | 4 | 6 |
| Character of bottom | sand bould. | clay | sand | gravel bould. | clay | mud | clay | bould. sand gravel | sand | mud | mud |
| Unit area (sq. in.) | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 2x3x3¼ | 16 | 16 | 16 |
| Fig. of material | | | | | 33 | | | | | | |
| Date (July) | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| *Elodea canadensis* | x | | | | x | | | | | x | x |
| *Eleocharis acicularis* | | | | | x | | | | | | |
| *Myriophyllum verticillatum* | | | | | x | | | | | x | x |
| *Myriophyllum scabratum* | | | | | | | | | | | x |
| *Najas flexilis* | x | | | x | x | | | | x | | x |
| *Nitella* | | | | | x | | | | | | x |
| *Pontederia cordata* | | | | | x | | | | | | |
| *Potamogeton foliosus* | | x | | | | | | | | | x |
| *Potamogeton friesii* | | | | | | | | | | | x |
| *Potamogeton interruptus* | x | x | | | x | | x | | x | x | x |
| *Potamogeton lucens* | | | | | x | | | | | | x |
| *Potamogeton richardsonii* | | x | | | x | | | | | x | x |
| *Potamogeton robbinsii* | x | | | | | | | | x | | |
| *Potamogeton zosterifolius* | | | | | x | | | | | | x |
| *Scirpus americanus* | | | | | x | | x | | x | | |
| *Scirpus occidentalis* | | | | | | | | x | | | |
| *Typha angustifolia* | | | | | x | | x | x | x | | |
| *Utricularia vulgaris* | | | | | | | | | | | x |
| *Vallisneria spiralis* | | | | | | | | | | x | x |

TABLE NO. 11. DEEP WATER HABITATS OF LOWER SOUTH BAY

| Habitat numbers | cxlvi | cxlvii | cxlviii | cxlix | cl | cli | clii | cliii | cliv | clv | clvi | clxi | clxii |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Field numbers | 1050 | 1047 | 1049 | 1048 | 1052 | 1045 | 1031 | 1030 | 1033 | 1032 | 1034 | 1044 | 1046 |
| Depth of water (feet) | 8 | 10 | 10 | 8½ | 12 | 11½ | 9 | 8 | 10 | 11 | 11 | 14 | 13 |
| Character of bottom | mud | mud | mud | mud | mud | mud | mud | mud | mud | mud | mud | mud | mud |
| Fig. of material | | | 36 | 37 | | | | | | | 38 | | |
| Date (July) | 27 | 27 | 27 | 27 | 27 | 27 | 25 | 25 | 25 | 25 | 25 | 27 | 27 |
| *Elodea canadensis* | | | | x | | | x | x | | x | x | | |
| *Lemna trisulca* | x | | | | | | | | | | x | | |
| *Myriophyllum verticillatum* | x | | | | | | x | x | | x | x | | |
| *Najas flexilis* | x | | x | x | | | x | | | | | | |
| *Potamogeton interruptus* | x | | | | | | | | | | | | |
| *Potamogeton lucens* | x | | x | | | | x | x | | x | x | | |
| *Potamogeton perfoliatus* | x | | | | | | x | x | | x | x | | |
| *Potamogeton richardsonii* | | | | | | | | x | | x | x | | |
| *Potamogeton zosterifolius* | x | | | | | | | | | | | | |
| *Vallisneria spiralis* | | x | x | x | x | | x | x | x | x | x | x | |

most numerous. In Table No. 11, each dredging is indicated, the area covered being 768 square inches (see page 23). On the map, fig. 1, each dredging is shown in its relation to the adjoining land areas.

### 3. South Shore of Lake East of Norcross Point

This territory may be divided into two areas, that bordering the shore and that of the deep water between Norcross Point and Dunham Island.

**1. Norcross Point Shore.** The shore of Oneida Lake east of Norcross Point (figs. 16, 17) is very bouldery and the water rather rapidly deepens to the 6-foot contour and still more rapidly to the 12-foot contour. The boulders are mostly of large size indicating the rough character of the water during storms from the north and east. Vegetation is not abundant, except in more or less isolated spots near the shore where the Water Willow (*Dianthera*) and Bulrush (*Scirpus*) grow in great profusion (fig. 17). The boulders are more or less covered with filamentous algæ which afford good feeding ground for mollusks and other aquatic animals (Table No. 12).

**2. Deep Water Area between Norcross Point and Dunham Island.** North of the Norcross Point shore the water deepens rapidly to 16 feet and then gradually to 18 and 19 feet (see cross section, fig. 4, L). The bottom material is of black, soft mud throughout the greater part of this area. In one spot, however, at depths of 14 and 15 feet (see map, fig. 1) there is a streak of gravel with some sand which extends in an east and west direction for several hundred feet. There is more or less algæ on the bottom in all depths of water. Vegetation is absent from the greater depths, apparently, occurring in but one dredging at 10 feet. The unit areas are the same as those given above under deep water habitats of Lower South Bay. (See Table No. 13.)

TABLE NO. 12. NORCROSS POINT HABITATS

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Habitat numbers | cxxx | cxxxi | cxxxii | cxxxiii | cxxxiv | cxxxv | cxxxvi | cxxxvii | cxxxviii | cxxxix | cxl | cxli | cxlii | cxliii |
| Field numbers | 1027 | 1028<br>1029 | 739–742 | 743 | 727 | 728 | 729–735 | 712 | 713<br>714 | 715 | 716 | 717<br>718 | 719–726 | 991<br>1054–7 |
| Distance from shore | 150 | 30 | 100 | 100 | 100 | 5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 1–2 |
| Depth of water (feet) | 5 | 3 | 4 | 2 | 1½ | ½ | 2¾ | 3½ | 3 | 3 | 3 | 3 | 1 | ½–2 |
| Character of bottom | sand | bould. | bould. | bould. | bould. | bould. | bould. | gravel | bould.<br>gravel | bould. | gravel | gravel<br>bould. | bould. | bould. |
| Unit area (sq. in.) | 16 | 4x3x2<br>5x2x5½ | 6x4x2½<br>6x4x2½<br>6x4x2½<br>8x4x4 | 6x4x2½ | 6x5x3 | 6x8x5 | 4x4x2<br>5x3x2½<br>5x3x1<br>5x4x3<br>5x5x1<br>6x6x3<br>4x3x3<br>5x4x3<br>5x5x4 | 16 | 16<br>4x3x4½ | 3x4x2½ | 16 | 2x4x2½ | 6x5x3½<br>6x2x1½<br>12x8x5<br>5x3x2<br>6x4x3<br>6x4x4<br>6x5x5 | 6x7x3 |
| Fig. of material | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Date (July) | 24 | 24 | 13 | 13 | 13 | 13 | 13 | 12 | 12 | 12 | 12 | 12 | 13 | 13–27 |
| *Dianthera americana* | .... | .... | .... | .... | x | x | x | x | x | .... | .... | .... | .... | x |
| *Scirpus americanus* | .... | .... | .... | .... | .... | .... | .... | x | x | .... | .... | .... | .... | x |
| *Vallisneria spiralis* | .... | .... | .... | .... | .... | .... | .... | .... | x | .... | .... | .... | .... | .... |

TABLE NO. 13. DEEP WATER HABITATS

| | | | | | |
|---|---|---|---|---|---|
| Habitat numbers | cxlv | clvii | clviii | clix | clx |
| Field numbers | 801 | 1037 | 1038<br>1039 | 1040–<br>1042 | 1043 |
| Depth of water (in feet) | 10 | 15 | 15 | 18 | 14 |
| Character of bottom | mud | mud<br>gravel | mud<br>gravel | mud | sand<br>gravel |
| Fig. of material | ..... | 39 | 40 | 41 | ...... |
| Date (July) | 15 | 26 | 26 | 26 | 26 |
| *Lemna trisulca* | x | ..... | ..... | ..... | ...... |
| *Myriophyllum verticillatum* | x | ..... | ..... | ..... | ...... |
| *Najas flexilis* | x | ..... | ..... | ..... | ...... |
| *Vallisneria spiralis* | x | ..... | ..... | ..... | ...... |

## 4. LOCALITIES AT A DISTANCE FROM LOWER SOUTH BAY

Several localities at some distance from the Lower South Bay region were visited and collections, more or less extensive, were made. These should be recorded, although the data does not appear in the quantitative tables.

**1. Tuttle Brook, Chittenango Creek.** This small stream empties into Chittenango Creek about three-fourths of a mile from the point of entrance into Oneida Lake (in a straight line) at the State Protectors' Camp. Although the brook is small, it fairly teems with life and would seem to afford good feeding ground for small fish. Filamentous algæ (*Cladophora fracta, Œdogonium grande,* and *Œdogonium regulosum*) are very abundant, in some places almost choking the water. Other plants noted were Water-weed (*Elodea canadensis*), Duck-weed (*Lemna trisulca*), and a Pond-weed (*Potamogeton* species). The bottom is of black mud. A pint of algæ was gathered from an area approximately 20 by 3 feet, bordering the shore, just above the bridge which crosses the stream at this point. Table No. 14 shows the animal life present. The gastropod mollusk (*Planorbis parvus*) and the amphipod (*Hyalella*) were the most abundant, followed by the beetle (*Creniphilus*) and chironomid larvæ. The large number of groups represented is noteworthy. A study of this little stream, as well as of the larger creek, would doubtless be of interest. The latter is said to be upwards of 35 feet deep, yet at the mouth it is but 12 feet deep and a short distance from shore the water is only three feet deep. The geological history of Chittenango Creek is probably very interesting and the correlation of the depth with its pre- and post-glacial history would be of interest and would probably explain the meaning of the great depth of the creek so short a distance from the shallow mouth. The crowfoot dredge (the only implement with the party when this creek was examined) was dragged over the bottom of the creek but the only results were a number of branches of trees and other debris. It was

TABLE NO. 14. ANIMAL LIFE OF TUTTLE BROOK (Field No. 857)

| | | |
|---|---|---|
| Mollusca | | |
| *Planorbis parvus* | 127 | mostly young and immature |
| *Planorbis exacuous* | 1 | adult |
| *Galba humilis modicella* | 10 | 5 mm. long |
| *Physa heterostropha?* | 6 | 3–4 mm. long |
| *Amnicola bakeriana* | 1 | adult |
| *Valvata tricarinata* | 2 | adults |
| *Pisidium* species | 7 | |
| | | 154 specimens |
| Amphipoda | | |
| *Hyalella knickerbockeri* | 92 | |
| Cladocera | | |
| *Simocephalus serrulatus* | 2 | |
| *Simocephalus vetulus* | 4 | |
| Isopoda | | |
| *Asellus communis* | 17 | |
| Hemiptera | | |
| *Notonecta*, nymph | 1 | |
| *Corixa*, nymph | 1 | |
| *Plea striola*, nymph and adult | 5 | |
| Coleoptera | | |
| *Haliplus ruficollis* | 1 | |
| *Helophorus nitidulus* | 1 | |
| *Helophorus inquinatus* | 1 | |
| *Helophorus lineatus* | 2 | |
| *Philhydrus ochraceus* | 1 | |
| *Bidessus affinis* | 1 | |
| *Creniphilus subcupreus* | 38 | |
| Diptera (larvae 25, pupæ 2) | | |
| *Chironomus* species | | |
| *Orthocladius* species | | |
| *Palpomyia* species | 27 | |
| Acarina | | |
| *Arrhenurus* | 1 | |
| | | 195 specimens |
| Total number of animals | | 349 specimens |

thought that mussels might be found in the deep water of the creek but none were collected, and probably none were present. A few dredgings with the rectangular dredge would be interesting.

**2. Johnson Bay, North Shore of Oneida Lake.** This embayment is directly across the lake from Lower South Bay. It is a small bay about a third of a mile long and over an eighth of a mile wide. The water is from four to six feet deep and the bottom is mostly of firm sand, with a few mud areas in sheltered places. Vegetation consists of Lake Bulrush (*Scirpus occidentalis*), Pickerel Weed (*Pontederia cordata*) and White Water Lily (*Castalia odorata*). The shore is lined with Swamp Loosestrife (*Decodon verticillatus*). Collections were made in three habitats as noted in Table No. 15. Many of the specimens were immature. The 911 habitat was on the leaves of the White Water Lily, one individual on each leaf. The sponge (*Heteromyenia*) was found attached to a leaf of *Scirpus occidentalis,* just below the surface of the water. It was quite abundant.

TABLE NO. 15. JOHNSON BAY HABITATS

| | | | |
|---|---|---|---|
| Field numbers | 709 | 910 | 911 |
| Depth of water (in feet) | 2–4 | 3–4 | ..... |
| Character of bottom | sand | sand | lily leaf |
| Date (July) | 12 | 12 | 12 |
| *Elliptio complanatus* | 6 | 10 | ..... |
| *Anodonta cataracta* | 5 | .... | ..... |
| *Anodonta grandis footiana* | 1 | .... | ..... |
| *Lampsilis luteola* | 2 | .... | ..... |
| *Bythinia tentaculata* | .... | .... | 1 |
| *Planorbis campanulatus* | .... | .... | 1 |
| *Physa warreniana* | .... | .... | 1 |
| *Heteromyenia repens* | .... | 1 | ..... |

**3. Graves Bay, South Shore of Oneida Lake.** This locality is a trifle over a mile east of Lower South Bay. The water is shallow for a great distance from shore, gradually deepening to the 6-foot contour which is 900 feet from shore.

The 4-foot contour is upwards of 600 feet from shore. The bottom is of hard sand and the vegetation is restricted to *Potamogeton robbinsii.* The points at either end of the bay are shallow and bouldery and have a heavy growth of *Dianthera* and *Scirpus occidentalis.* Two mussels, *Elliptio complanatus* and *Lampsilis luteola,* were collected in water 5–6 feet deep, by Professor T. L. Hankinson, *Elliptio* being 90 per cent more abundant than *Lampsilis.*

4. **Frenchman Island.** Mr. A. G. Whitney collected on the north side of Frenchman Island, in a sheltered, swamp-like pool of water protected from the roughness of the lake by a bar (see F. C. Baker, '16a, p. 72, and fig. 22 on p. 85). The water was 18 inches deep and the bottom of mud. From the leaves of the Arrow-head (*Sagittaria arifolia*) the following mollusks were collected:

3 *Galba catascopium,* young, 5½, 8, 9 mm.
3 *Planorbis binneyi,* young, 4, 4, 7 mm.
1 *Segmentina armigera,* adult.
1 *Bythinia tentaculata,* young, 4 mm.
3 *Amnicola bakeriana,* adult.
1 *Amnicola bakeriana nimia,* adult.

## Systematic List of the Plants of Lower South Bay

### 1. Seed Plants of the Bottom

The majority of the plants here listed were identified by Dr. Herman S. Pepoon, of Chicago, Illinois. The classification is that of Robinson and Fernald ('08). As before stated, this list is far from being exhaustive, only those plants being collected that were more or less intimately associated with the animal life. A careful plant survey of this territory would undoubtedly bring to light many aquatic species not before recorded from this region.

MONOCOTYLEDONEÆ

FAMILY TYPHACEÆ

*Typha angustifolia* L. Narrow- leaved Cat-tail.

FAMILY SPARGANACEÆ

*Sparganium eurycarpum* Engelm. Bur-reed.

FAMILY NAJADACEÆ

*Potamogeton natans* L. Floating Pond-weed.
*Potamogeton lucens* L. Shining Pond-weed.
*Potamogeton prælongus* Wulf. Pond-weed.
*Potamogeton richardsonii* (Benn.) Rydb. Richardson's Pond-weed.
*Potamogeton perfoliatus* L. Clasping-leaf Pond-weed.
*Potamogeton zosterifolius* Schum. Eel-grass Pond-weed.
*Potamogeton friesii* Rupr. Fries' Pond-weed.
*Potamogeton foliosus* Raf. Leafy Pond-weed.
*Potamogeton interruptus* L. Pond-weed.
*Potamogeton robbinsii* Oakes. Robbin's Pond-weed.
*Najas flexilis* (Willd.) Rostk. and Schmidt. Slender Naiad.

FAMILY ALISMACEÆ

*Sagittaria latifolia* Willd. Broad-leaved Arrow-head.
*Sagittaria arifolia* Nutt. Narrow-leaved Arrow-head.

FAMILY HYDROCHARITACEÆ

*Elodea canadensis* Michx. Water-weed.
*Vallisneria spiralis* L. Wild Celery; Eel-grass.

FAMILY CYPERACEÆ

*Eleocharis acicularis* (L.) R. and S. Needle Spike Rush.
*Scirpus smithii* Gray. Smith's Bulrush.
*Scirpus americanus* Pers. American Bulrush.
*Scirpus occidentalis* (Wats.) Chase. Lake Bulrush.
*Carex trichocarpa* Muhl. Sedge.

### Family Lemnaceæ

*Spirodela polyrhiza* (L.) Schleid. Duck-weed.
*Lemna trisulca* L. Deck-week; Ducks Meat.

### Family Pontederiaceæ

*Pontederia cordata* L. Pickerel-weed.

### Family Iridaceæ

*Iris versicolor* L. Larger Blue Flag.

## DICOTYLEDONEÆ

### Family Salicaceæ

*Salix nigra falcata* (Pursh) Torr. Black Willow.

### Family Nymphaceæ

*Nymphæa advena* Ait. Cow Lily.
*Castalia odorata* (Ait.) Woodville and Wood. Sweet-scented Water Lily.

### Family Cruciferæ

*Radicula aquatica* (Eat.) Robinson. Lake Cress.

### Family Lythraceæ

*Decodon verticillatus* (L.) Ell. Swamp Loosestrife.

### Family Haloragidaceæ

*Myriophyllum verticillatum* L. Water Milfoil.
*Myriophyllum scabratum* Michx. Water Milfoil.

### Family Lentibulariaceæ

*Utricularia vulgaris americana* Gray. Greater Bladderwort.

### Family Acanthaceæ

*Dianthera americana* L. Water Willow.

### Family Rubiaceæ

*Cephalanthus occidentalis* L. Buttonbush.

### 2. Algæ and the Lower Plants

Lower South Bay is noteworthy for the great development of the lower plants known generally as algæ. These lowly plants are of primary importance because they form the food of a large percentage of animals upon which fish feed and even supply fish directly with food. Dr. MacClement remarks ('15, p. 202) that: "The quantity of unicellular plants per unit volume of water decides the quantity of the Protozoa, Rotifera and Crustacea which may inhabit the waters. These latter are known to serve as the chief if not the only food of the young and small fish. Favorable conditions of shelter and food are indispensable to the growth and rapid development of the young food fish. We are therefore quite safe in deciding that a prime biological condition for a plentiful fish fauna is the presence of an abundant growth of microscopic plants."

"The surroundings most favorable for the growth of the more minute algæ are quiet waters, sunlight, and a plentiful growth of larger plants such as *Chara, Potamogeton, Elodea, Utricularia,* and *Myriophyllum* as bottom and shore growths. These larger plants serve as shelters and homes for the minute forms, and wherever the former are absent, we cannot expect the latter to be abundant." MacClement states that *Chara* is the most important substratum for minute algæ.

Platt ('15) has made a very interesting study of the "blanket algæ" of shallow, permanent and temporary pools at Ithaca, New York. The filamentous algæ included 16 species of *Spirogyra,* and representatives of the genera *Mougeotia, Zygnema, Vaucheria, Oscillatoria, Ulothrix, Microspora,* and *Anabæna.* These associated genera varied in seasonal abundance, and at certain times some genera were absent. Diatoms and desmids were abundant. These algæ floated in thin layers, or formed thick masses.

The animal population was found to be large and varied. The Protozoa and Rotifera were well represented. Of oligochæte worms, three genera were observed. Planarian and other turbellarian worms were present. Of the mollusks, *Lymnæa, Physa,* and *Planorbis* occurred. The statement that these snails are 'not regular inhabitants of the surface algæ, but merely forage there when there is little or no sunlight" is interesting, and may be true for small bodies of water, but not for larger ones, where these animals have been observed to crowd the algæ or other plants on the surface, in direct sunlight, even during the hot days of summer. This has been noted not only in Oneida Lake but in other lakes. Four genera of Cladocera, three of Copepoda, one of Isopoda, and two of Amphipoda were collected. A few nymphs of Ephemerida and Odonata were noted as well as one genus, *Corisa,* of Hemiptera. Larvæ of Diptera, especially *Chironomus,* were abundant, though, curiously enough, mosquito larvæ were notably rare. Several larval beetles as well as adults were collected, among them *Hydroporus, Creniphilus,* and *Helophorus.*

The dominant or principal forms of this algal community are, among the algæ, *Spirogyra, Mougeotia,* and *Zygnema,* which constitute the "blankets." In Oneida Lake, *Cladophora, Spirogyra,* and *Œdogonium* were the dominant genera. Among the larger animals *Cyclops* and the larvæ of *Chironomus* were most abundant. Quantitative valuations of the animals of these pools would be of value for comparison with those of Lower South Bay.

As stated by Platt ('15, p. 761) "the population of the 'blanket-algæ' has its producers and its consumers, its hunters and its hunted, each readily exchanging rôles as occasion demands," and the same condition has been shown to be true, on a larger scale, of the Oneida Lake algal communities. The significant fact brought out in this study, as in the investigations made at Lower South Bay, is that the presence of filamentous algæ in abundance profoundly affects the animals, providing a food supply of sufficient amount to meet the requirements of a large population of herbivorous animals, which, in their turn, provide for the predaceous animals of the habitat.

The conditions necessary for the abundant growth of algæ are admirably met in Lower South Bay, and as a result the algal flora is abundant in both species and individuals, the entire bottom of the bay being covered with plants of this group. Not only the bottom, but the higher vegetation itself is covered with these plants which form a thick blanket in many places, and fairly swarm with animal life — mollusks, worms, insects, crustaceans — providing a food supply of large dimensions. *Chara* forms a carpet on the bottom in many places, especially in the west end of the lower bay. *Nitella* is also abundant in spots.

The species of filamentous algæ, such as *Cladophora, Ulothrix, Œdogonium,* and *Spirogyra,* cover the bottom in many places and form a thick blanket. The plankton algæ, such as *Rivularia, Tolypothrix, Phormidium,* and *Scytonema,* are abundant in many habitats. Diatoms, especially *Gomphonema* and *Coconeis,* were noted abundantly in *Cladophora* and some other species of algæ. It is probable that a rich flora of both diatoms and desmids exists in this bay and lake.

It is of value to know the relative number of species found on different kinds of bottom material. Thus on boulder bottom there were 14 species; on gravel bottom 5 species; on sand bottom 24 species; on clay bottom 13 species; and on mud bottom 12 species. It will be noted that a sandy bottom produced almost twice as many species as any other variety of bottom material. Forty-one species were collected, 36 of which (including two species new to science) are determined specifically. The algæ were identified by Dr. E. N. Transeau, of the Ohio State University, Columbus, Ohio. The detailed field numbers and habitat relations of the algæ are shown in Tables Nos. 1–15.

## List of Algæ

### CHARACEÆ

*Chara fragilis* Linn.
*Chara* species.
*Nitella* species.

### CHROOCOCACEÆ

*Aphanotheca saxicola* Nägeli.

### OSCILLATORIACEÆ

*Phormidium ambiguum* Gomont.
*Phormidium netzii* (Menegh.) Gomont.

*Phormidium tenuis* (Menegh.) Gomont.
*Microcoleus lacustris* (Rabenh.) Farlow.

NOSTOCACEÆ

*Cylindrospermum comatum* Wood.

SCYTONEMATACÆ

*Scytonema crispum* (Ag.) Bornet.
*Tolypothrix limbata* Thuret.
*Tolypothrix tenuis* Kütz.
*Calothrix adscandens* (Nägeli) Born. & Flah.
*Rivularia paradoxa* (Wolle) DeToni.
*Rivularia pisum* Agardh.
*Rivularia* species.

STIGONEMACEÆ

*Stigonema hormoides* (Kütz.) Born. & Flah.

ZYGNEMACEÆ

*Zygnema* species.
*Spirogyra fluviatilis* Hilse.
*Spirogyra pratensis* Transeau.
*Spirogyra* species.

MESOCARPACEÆ

*Mougeotia americana* Transeau n. var.
*Mougeotia gracillima* (Hass.) Wittrock.
*Mougeotia* species.

ULOTRICHACEÆ

*Ulothrix subtilissima* Rabenh.
*Ulothrix zonata* Kütz.
*Microspora amœna* (Kütz.) Rabenh.
*Œdogonium crassiusculum idioandrosporum* N. & W.
*Œdogonium crassum longum* Transeau n. sp.
*Œdogonium flavescens* Wittrock.
*Œdogonium grande* Kützing.
*Œdogonium grande angustum* Hirn.
*Œdogonium rugulosum* Nordst.

*Œdogonium oblongum majus* (Nordst.) Hirn.
*Œdogonium spirale* Hirn.
*Œdogonium tumidulum* (Kütz.) Wittrock.
*Œdogonium* species.
*Binuclearia tetrana* Wittrock.

CHÆTOPHORACEÆ

*Chætophora incrassata* Hazen.
*Stigeoclonium falklandicum* Kützing.
*Coleochaete scutata* Breb.

HERPESTEIRACEÆ

*Herpesteiron confervicola* Nägeli.

CLADOPHORACEÆ

*Rhizoclonium hieroglyphicum* (Ag.) Kütz.
*Cladophora fracta* (Dillw.) Kütz.

# COMPOSITION OF THE BOTTOM FAUNA OF LOWER SOUTH BAY AND VICINITY

## Introduction

In a previous paper (F. C. Baker, '16, pp. 120–133) an attempt was made to roughly estimate the amount of food available for fish in the western part of Oneida Lake. This attempt was based on estimates of the total life furnished by counting the animals in an area estimated to be one foot square. While indicating in a general way the possible total amount of food present, the work was necessarily faulty and inaccurate because of lack of time and apparatus to properly carry on detailed investigations. It was therefore decided that the work of the 1916 field season should be devoted exclusively to the quantitative study of a portion of the lake, and as Lower South Bay was easily accessible and was also a favorite resort for fishermen and anglers, it was selected by Dr. Adams as a promising field for carrying on this kind of investigation. The partly enclosed character of the bay, as well as the variation in depth and character of the bottom, also made it favorable for statistical study. The physical characteristics, the vegetation, and the methods of securing the data have been described in the previous chapters.

As has already been stated on a previous page the inspiration for the present study was given by studies of the previous year (Baker, '16, p. 316) and by the work of the Danish zoologist, Dr. C. G. Joh. Petersen ('15, '16, etc.), who was the first student (in 1896) to count the actual number of animals on the bottom in a limited area of water ('11, page 5). This author's quantitative studies of the animal communities of the sea bottom in Danish and adjoining marine waters have been epoch-making. Petersen's statement in one of his reports ('11, p. 71), though referring to marine studies, may well apply to investigations of our inland lakes:

" We have here a new field of work, which is very large and seems promising. Enumeration of the bottom animals does not take up so much time as counting of the plankton; and when the percentage of dry matter has been determined for the different years, the number of individuals, as also the total rough weight of the species for 100 stations or more, will give good information regarding the mass of the animal life per square meter."

"I am inclined to believe, that an evaluation with such bottom-samplers could be carried out comparatively easily, and would lead much further than plankton determinations alone can, in the direction of the determination of the mass of fish food. We may certainly with Hensen consider it a *condito sine qua non*, that we must know on the main points the capacity of a water as regards the production of fish-nourishment, in order to be able to judge as to its rational exploitation in the interest of the fisheries. It will, however, scarcely be an easy matter to determine exactly, by quantitative investigation of the food animals alone, the quantity of food available yearly, annual food-production, for the consumption of the fishes or other animals in any water; nor is it practically possible in the case of the plankton; it is only the logical consequence of our scientific mode of working to attempt to do such a thing. Both Hensen and the present work endeavor therefore at the same time to find another, more direct way, namely, to determine the production of food by investigating, what is actually used of the food by fishes or other animals which have lived on this food. When we have determined in this way, *how much a sea-bottom can produce, it is comparatively easy by means of the bottom-sampler to compare this bottom with another* and thus obtain a good insight into, whether the one or the other is best suited for the production of the one or the other kind of food-animals, this or that species of fish, and whether on the whole it is more productive than the other. It is this I have in mind in using the expression 'valuation of the bottom.'"

Fish culturists and fishermen alike will agree that this is sound logic and really goes to the bottom of the subject, for until we have detailed knowledge of the life of a body of water, including a fairly accurate estimation of the quantity of its biota, we cannot intelligently begin the rearing of fish. In

FIG. 21. Invertebrate animals on a boulder, 4 x 3 x 1½ inches, Habitat No. xliii, Field No. 862. Note the large number of the snail *Galba catascopium.*

other words we must know the mutual relations between all the aquatic organisms before we can hope to successfully disturb the balance of nature by artificial fish culture. It is the purpose of this chapter to indicate the valuation of the bottom animals and plants of Lower South Bay. The number of animals on each kind of bottom will be considered and these results will be used to determine as accurately as possible the value of this life to the fish fauna as food. As stated by Petersen, this will afford a basis for comparison with other bodies of water.

As indicated in the introduction, collections were made on soft bottoms (mud, sand, and clay) with a Walker dredge flattened on one side so as to scrape up a portion of the bottom measuring about 10 centimeters square, or 100 square centimeters (the area covered was slightly more than 100 square cm., being four inches square or 16 square inches). This is about the area used by Petersen in his marine investigations (one-tenth of a square meter or 3.93 inches square = about 15.44 square inches). Petersen's bottom sampler is useful only on a soft bottom and its small size causes it to miss large animals, as large mollusks of the sea and the fresh-water clams of our lakes, and it might be desirable to use a larger sampler when investigating a bottom containing quantities of the large animals. Ekman ('15, p. 166) has devised a bottom sampler covering an area 5 decimeters square, but this seems almost too large for practical work. For soft bottoms upon which quantities of small animals live the Petersen bottom-sampler is the best apparatus known for obtaining accurate statistical data. A Petersen bottom-sampler was not available for use during the 1916 field season, and the Walker dredge was found to be satisfactory in the shallow water (down to six feet). The deeper parts of the bay were dredged with the ordinary rectangular dredge, a small area approximately 16 x 48 inches, being covered at each haul (see p. 23). For rocky shores the only method was to examine a number of boulders, measure them, and pick off all the animal and vegetable life. As is usually the case in general field work it was found that the best results were obtained by using a variety

FIG. 22. Invertebrate animals on a boulder, 11 x 10 x 6 inches, Habitat No. xlv, Field No. 869. The dominant species are *Goniobasis livescens, Psephenus lecontei* (larva), *Helicopsyche borealis* and *Heptagenia* larvæ.

of methods. The material collected was all sorted in glass dishes, with the aid of hand lenses up to ten diameters.

Petersen ('11, pp. 50–53) counted and weighed the animals obtained, giving both "dried" and alcoholic weight. His material varied so greatly in size that a measurement of mass per unit area was necessary. In making the studies in Lower South Bay all of the individuals were counted. It was thought that counting would be more practicable, and suggestive in studies of the contents of the stomach and digestive tract of fishes. By this means a uniformity of method is secured for both stomach contents and for the estimates of the food supply.

## Comparison of the Bottom Habitats of Lower South Bay

For the purposes of this statistical study Lower South Bay includes all of the bay proper and the area extending eastward and northward within a line drawn eastward from Long Point which meets another line drawn northward from Norcross Point (see fig. 1). This area embraces 881 acres and the total area sampled, including certain territory in the vicinity of the bay, aggregates 1,164 acres (see the map, fig. 1).

Petersen selected mollusks and echinoderms to characterize his animal communities, because these groups comprise the greater part of the bottom fauna in these marine waters and also because they are not seasonal animals. Their ease of preservation for future reference, because of the hard exoskeleton, was also another feature in their favor. The marine communities were divided into principal species, attendant species, and casual species, those with the greatest frequency being principal and those occurring but rarely being casual species. For the reason that mollusks are more numerous than any other single group they have been chosen to characterize the different communities in Lower South Bay; they also usually contain the principal or dominant species. Attendant species may be mollusks but are more often some group of associated animals. For purposes of better comparison the quantitative data is arranged under several heads, each based on the character of the bottom material — boulder, gravel, sand, clay, mud, and vegetation. Certain areas in the

FIG. 23. Invertebrate animals on a boulder, 4½ x 3 x 1 inches, Habitat No. xlviii, Field No. 878. The dominant animals are the scuds, *Hyalella.* The absence of the usual rock-loving species shown in Fig. 22 is to be noted.

| |
|---|
| Habitat numbers.... |
| Field numbers...... |
| Distance from shore |
| Depth of water (in fe |
| Number of units (bot |
| Figures of animal life |
| Algæ |
| *Chætophora incrass* |
| *Cladophora fracta*. |
| *Œdogonium* species |
| *Spirogyra fluviatili* |
| *Tolipothrix limbata* |
| Mollusca. |
| *Goniobasis livescens* |
| *Amnicola bakerianc* |
| *Amnicola oneida*.. |
| *Valvata tricarinata* |
| *Galba catascopium*. |
| *Planorbis antrosus*. |
| *Planorbis binneyi*, |
| *Planorbis campanui* |
| *Planorbis hirsutus* |
| *Planorbis parvus*.. |
| *Planorbis trivolvis f* |
| *Physa warreniana*. |
| *Physa integra*..... |
| Total Mollusca. |
| Porifera |
| *Spongilla* species.. |
| Turbellaria |
| *Planaria maculata*. |
| Hirudinea |
| *Erpobdella punctata* |
| *Glossiphonia comple* |
| Oligochæta |
| *Stylaria* species.... |
| Enchytræidæ ..... |
| Naididæ.......... |
| Tubificidæ........ |
| Cladocera |
| *Acroperus harpæ*... |
| *Alona quadrangular* |
| *Camptocercus rectirc* |
| *Chydorus sphæricus* |
| *Eurycercus lamellati* |
| *Simocephalus serrul* |
| Decapoda |
| *Cambarus propinqu* |
| Ostracoda |
| Cyprididæ....... |
| Amphipoda |
| *Hyallella knickerboc* |
| Isopoda |
| *Asellus communis*. |
| Ephemerida |
| *Bætis* species, nymp |
| *Heptagenia* species, |
| Odonata |
| *Argia putrida*..... |
| Trichoptera |
| *Agraylea multipunc* |
| *Helicopsyche boreali* |
| *Hydroptila* species. |
| *Molanna* species... |
| Diptera |
| *Chironomus* species |
| *Orthocladius* species, |
| *Tanytarsus* species. |
| Lepidoptera |
| *Elophila* species, lar |
| Coleoptera |
| *Psephenus lecontei*, l |
| Total associated a |
| Total animal life |

TABLE No. 16. NUMBER OF ANIMALS ON BOULDER BOTTOM

| Habitat numbers | vi | viii | x | xxi | xl | xli | xlii | xliii | xliv | xlv | xlviii | cvi | cxiii | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Field numbers ........ .. | 744–746 | 751–753 | 761 762 | 804 807 | 850 851 | 859 | 860–862 | 863 | 864 865 | 866–869 | 876–878 | 1002 | 1005–1007 | |
| Distance from shore (feet) ... | 50 | 50 | 5 | 50 | 50 | 200 | 100 | 50 | 125 | 30 | 200 | 50 | 20 | |
| Depth of water (in feet) ... | 2½ | 3 | 1½ | 3½ | 2½ | 6 | 3½ | 3½ | 3 | 1½ | 3 | 1 | 2½ | |
| Number of units (boulders) . | 1 | 3 | 20 | 4 | 1 | 1 | 4 | 1 | 2 | 4 | 3 | 1 | 1 | 46 |
| Figures of animal life ....... | | | | | | | | 21 | | 22 | 23 | | | |
| Algæ | | | | | | | | | | | | | | |
| *Chætophora incrassata* | | | | | | | | | | x | | x | | |
| *Cladophora fracta* | | x | | | | | | | | | | | | |
| *Œdogonium* species | | | | x | | | | | | x | | | | |
| *Spirogyra fluviatilis.* | | | | x | | | x | x | x | x | x | | | |
| *Tolypothrix limbata* | | | | | | | | | | x | | | | |
| Mollusca. | | | | | | | | | | | | | | |
| *Goniobasis livescens* . | 1 | | 8 | | | | | | | 6 | | | | 15 |
| *Amnicola bakeriana nimia* | | | 2 | 1 | | | | | 6 | | | | | 9 |
| *Amnicola oneida* | | | 1 | 1 | | 1 | | | 1 | | | | | 4 |
| *Valvata tricarinata* | | | | 1 | | | 1 | 3 | | | | | | 5 |
| *Galba catascopium* | | 3 | 20 | 9 | 3 | 2 | 28 | 6 | | 3 | 7 | | | 81 |
| *Planorbis antrosus* | | | 1 | | | | | | | | | | | 1 |
| *Planorbis binneyi.* | | | | | | | | | | | | 1 | | 1 |
| *Planorbis campanulatus* | | | 5 | | | | | | | 1 | | | | 6 |
| *Planorbis hirsutus* | | | 1 | 1 | | | | | | | | | | 2 |
| *Planorbis parvus* | | | 2 | | | | | | | | | | | 2 |
| *Planorbis trivolvis fallax* | | | 1 | | | | | | | | | | | 1 |
| *Physa warreniana* | | | 24 | | | | | | | 1 | | | | 25 |
| *Physa integra* | | | 6 | | | | | | | 1 | | | | 7 |
| Total Mollusca .... | 1 | 3 | 71 | 13 | 3 | 3 | 29 | 9 | 7 | 12 | 7 | 1 | | 159 |
| Porifera | | | | | | | | | | | | | | |
| *Spongilla* species . | | | | | | | | x | | | x | | | |
| Turbellaria | | | | | | | | | | | | | | |
| *Planaria maculata* ... .. | | 5 | | | | | | | | 3 | | | | 8 |
| Hirudinea | | | | | | | | | | | | | | |
| *Erpobdella punctata* .. | | | 2 | 2 | | | 1 | | | | | | | 5 |
| *Glossiphonia complanata* | | | | | | | | 1 | | 1 | | | | 2 |
| Oligochæta | | | | | | | | | | | | | | |
| *Stylaria* species | | | | 5 | | | 6 | | 7 | | | | | 18 |
| Enchytræidæ | | | | | | | 2 | | | | | | | 2 |
| Naididæ | | | | 1 | | | 2 | | | | 5 | | | 8 |
| Tubificidæ . | | | | | | | | | 1 | | | | | 1 |
| Cladocera | | | | | | | | | | | | | | |
| *Acroperus harpæ* ..... | | | | | | | | | | | 2 | | | 2 |
| *Alona quadrangularis* | | | | | | | 3 | | | | | | | 3 |
| *Camptocercus rectirostris* | | | | | | | 2 | | | | 2 | | | 4 |
| *Chydorus sphæricus* . | | | | | | | 2 | | | | | | | 2 |
| *Eurycercus lamellatus* | | | | 7 | | | | | | | | | | 7 |
| *Simocephalus serrulatus* | | | | 5 | | | 17 | | | | | | | 22 |
| Decapoda | | | | | | | | | | | | | | |
| *Cambarus propinquus* .... | .... | . | 9 | .... | .... | .... | 1 | ... | .... | .... | .... | .... | ... | 10 |
| Ostracoda | | | | | | | | | | | | | | |
| Cyprididæ | | | | | | | 4 | | | | 2 | | | 6 |
| Amphipoda | | | | | | | | | | | | | | |
| *Hyalella knickerbockeri* .. | ... | | ... | 24 | .... | .... | 13 | . | 10 | .... | 26 | .... | ... | 73 |
| Isopoda | | | | | | | | | | | | | | |
| *Asellus communis* .... | ... | | .. | .... | .... | .... | ... | 1 | .... | .... | .... | .... | .... | 1 |
| Ephemerida | | | | | | | | | | | | | | |
| *Bætis* species, nymph ... | .... | .. | ... | .... | .... | .... | .... | . | .. | .. | 1 | .... | .... | 1 |
| *Heptagenia* species, nymph | .. | 1 | 1 | .... | .... | .... | .... | . | .... | 5 | ... | 2 | .... | 9 |
| Odonata | | | | | | | | | | | | | | |
| *Argia putrida* ........ . | | . | 2 | ... | .... | .... | .. | | | | | | . | 2 |
| Trichoptera | | | | | | | | | | | | | | |
| *Agraylea multipunctata*.... | | 3 | .. | 2 | .... | .... | ... | 1 | ... | 3 | ... | .... | .... | 9 |
| *Helicopsyche borealis*..... | 18 | 13 | 8 | 1 | . | .... | . | ... | .. | 18 | ... | 1 | 1 | 60 |
| *Hydroptila* species ...... | . | | ... | 2 | .. | .... | 6 | 1 | ... | 10 | 1 | .... | .... | 20 |
| *Molanna* species.......... | ... | 2 | .. | ... | .... | .... | ... | | | ... | .... | .... | .... | 2 |
| Diptera | | | | | | | | | | | | | | |
| *Chironomus* species .... . | 2 | 2 | 5 | .... | .. | ... | ... | 3 | ... | 8 | 3 | .... | 1 | 24 |
| *Orthocladius* species. ... .. | .. | | .. | ... | .. | .... | | | | 2 | .... | .. | .... | 2 |
| *Tanytarsus* species | | | | | . | | | | | .... | 2 | .... | ... | 2 |
| Lepidoptera | | | | | | | | | | | | | | |
| *Elophila* species, larva .. | .. | 1 | ... | .. | .. | .. | ... | . | .... | .... | .... | .... | .... | 1 |
| Coleoptera | | | | | | | | | | | | | | |
| *Psephenus lecontei*, larvæ .. | | . | 11 | ..... | .... | . .. | .. | | ... | 8 | ... | ... | .... | 19 |
| Total associated animals | 20 | 27 | 38 | 49 | 0 | 0 | 59 | 7 | 18 | 58 | 44 | 3 | 2 | 325 |
| Total animal life | | | | | | | | | | | | | | 484 |

vicinity of Lower South Bay are also included in the discussion.

**Life on the Boulder and Gravel Bottom.** As already explained, the amount of life on the boulders was ascertained by measuring a number of boulders and carefully removing and preserving all of the life on them. Forty-six such units were examined, the average area being 4½ by 3 inches, or 13½ square inches. Of animal life the total for the 46 units was 159 mollusks and 325 associated animals, or 3.45 mollusks and 7.06 associated animals per unit area. On the gravel bottoms, which were closely associated with the boulder bottoms, 34 units of 16 square inches area were examined; the total molluscan life on these units was 306 and the associated animal life 355, or an average of 9. mollusks and 10.44 associated animals per unit area. Combining the average life of both boulder and gravel areas we have, after reducing the boulder area of 13½ square inches to the gravel unit of 16 square inches, 6.54 mollusks and 9.40 associated animals per unit area four inches square. The boulder and gravel areas cover 20 acres and there is thus calculated, on the basis of the average of 80 samples, a population of 51,341,558 mollusks and 73,758,405 associated animals. The total animal population is estimated at 125,099,964* individuals in the 20 acres covered with gravel and boulders (see figures 21–24, which show the approximate number of animals in unit areas of boulder, 13½ inch unit, and gravel, 16 inch unit, bottoms).

In the tables of animal life on the boulder and gravel bottoms (Nos. 16, 17) it will be noted that on boulder bottoms the

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* The computations for the results recorded above are as follows: 43,560 (sq. ft. in acre) × 144 (sq. inches in foot) = 6,272,640 square inches in one acre; × 20 acres = 125,452,800 square inches ÷ 16 (sq. inches in unit area) = 7,840,800 unit areas in 20 acres; × 6.54 mollusks per unit area = 51,341,588 mollusks. 7,840,800 unit areas × 9.40 associated animals per unit area = 73,758,405 associated animals + 51,341,558 = 125,099,964, the total macroscopic animal population in 20 acres.

In the original computations, the averages of the mollusks and of the associated animals were carried out to the third decimal point (as 6.548 and 9.407 above), and the calculations of population are based on these figures. In all of the computations of the *macroscopic* fauna published in this paper, the third decimal number has been omitted but the multiplication totals are based on these three decimal figures.

FIG. 24. Invertebrate animals of a 16 square inch unit on gravel bottom, Habitat No. xxii, Field No. 793. *Amnicola* and oligochaete worms predominate. *Helicopsyche* and *Galba* represent the rock-dwellers.

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TABLE NO. 17. NUMBER OF ANIMALS ON GRAVEL BOTTOM

| Habitat numbers | vi | xvi | xxii | xxxix | xl | xlvii | ci | ciii | civ | cix | cxiii | cxvii | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Field numbers | 744–746 | 775–778 | 793 794 | 849 | 850 851 | 872 875 | 981–983 | 986 987 | 988–990 | 1003 | 1005–1007 | 1012 | |
| Distance from shore (feet) | 50 | 25 | 100 | 50 | 50 | 100 | 200 | 100 | 250 | 100 | 20 | 20 | |
| Depth of water (in feet). | 2½ | 1½ | 2½ | 3 | 2½ | 2½ | 3 | 3 | 6 | 1½ | 2½ | 3 | |
| Number of units (16 sq. in.) . | 2 | 3 | 2 | 1 | 1 | 4 | 6 | 2 | 3 | 1 | 7 | 2 | 34 |
| Figures of animal life. . | | .... | 24 | ..... | .... | .. | ... | .... | ..... | | | | |
| Algæ | | | | | | | | | | | | | |
| *Chara* species | | x | x | | | | x | | | | | | |
| *Cladophora fracta* | | x | | x | | x | | | | | | | |
| *Cylindrospermum comatum* | | | | | | | | | | x | | | |
| *Microcarpa amœna* | | | | x | | | | | | | | | |
| *Microcoleus lacustris* | | | | x | | | | | | | | | |
| *Œdogonium* species | | x | x | | | | x | x | x | | | | |
| *Rivularia pisum* | | | | | | | x | | | | | | |
| *Rivularia* species | | | | | | | | | | x | | | |
| *Spirogyra* species | | | x | | | x | | | | | | | |
| *Zygonema* species | | | | | | x | | | | | | | |
| Mollusca | | | | | | | | | | | | | |
| *Sphærium vermontanum* | 1 | | 2 | | | 1 | 23 | 3 | | 1 | 11 | 11 | 53 |
| *Musculium* species | | 1 | | | | | | | 2 | | | | 3 |
| *Pisidium compressum* | | | | | 1 | | | | | | | | 1 |
| *Pisidium complanatum* ...... | | | 1 | | | | | | | | | | 1 |
| *Pisidium scutellatum* .... | | | | 3 | 2 | 11 | | | | | | | 16 |
| *Pisidium s. cristatum* | | | | | | | 3 | | | | | | 3 |
| *Pisidium variabile* | | | | 2 | | | | | | | | | 2 |
| *Pisidium* species | | | | 3 | 1 | | | 1 | 1 | | | | 6 |
| *Goniobasis livescens* ..... | 2 | | | | | | | | | | | | 2 |
| *Amnicola bakeriana* | | 3 | 7 | | 1 | | 9 | 1 | 5 | | 1 | | 27 |
| *Amnicola oneida* | | 9 | 10 | | 6 | [illegible] | 6 | 2 | 5 | | 1 | | [illegible] |
| *Amnicola bakeriana nimia* | | | 11 | | | | | | | 1 | | | 12 |
| *Bythinia tentaculata* | | | | | | | | | | 1 | | | 1 |
| *Valvata bicarinata normalis* | | | 1 | | | | | | | | | | 1 |
| *Valvata tricarinata* | | 3 | | | 1 | | | 1 | 2 | | | | 7 |
| *Galba catascopium* | 4 | 3 | 7 | | 13 | 19 | 7 | | 3 | 2 | | 1 | 59 |
| *Planorbis antrosus* | | 2 | | | | | | | | | 2 | | 4 |
| *Planorbis campanulatus* | | | 1 | | | | | 1 | | | | | 2 |
| *Planorbis deflectus* | | | | | 1 | | | | | | | | 1 |
| *Planorbis exacuous* | | | | | | | 1 | | | | | | 1 |
| *Planorbis hirsutus* | | | 1 | 1 | | | | | 1 | | | | 3 |
| *Planorbis parvus* | | 13 | 5 | | | 1 | 5 | | | 4 | | | 28 |
| *Planorbis trivolvis fallax* | | | | | | | | | | 4 | | | 4 |
| *Physa warrentana* ..... | 1 | | | | 1 | 1 | | | | 15 | 2 | | 20 |
| *Ancylus parallelus* | | | | | | | | | 1 | | | | 1 |
| Total Mollusca | 8 | 34 | 52 | 0 | 27 | [illegible] | 54 | 9 | 20 | 28 | 17 | 12 | 306 |
| Porifera | | | | | | | | | | | | | |
| *Spongilla* species. . | | | | | | | x | x | | | | | |
| Oligochæta | | | | | | | | | | | | | |
| *Pristina* species | | | | | | | | | 1 | | | | 1 |
| *Stylaria* species | | 5 | | | | 1 | [illegible] | 1 | | | | | 24 |
| Enchytræidæ | | | | | | | | | 1 | | | | 1 |
| Naididæ | | | 14 | 21 | | | 19 | | | | | | 54 |
| Tubificidæ | 1 | | 20 | 9 | | | | 1 | | | | | 31 |
| Incertæ sedis | | | | | | 2 | | | | | | | 2 |
| Cladocera | | | | | | | | | | | | | |
| *Acroperus harpæ* . | | | 12 | | | | | | | | | | 12 |
| *Alona quadrangularis* | | | | | | 1 | | | | | | | 1 |
| *Eurycercus lamellatus* | | | | | | | | | 2 | | | | 5 |
| *Sida crystallina* . | | | | | | | | 1 | 6 | | | | 7 |
| *Simocephalus serrulatus* | | 2 | 8 | | | | 1 | | 17 | | | | 28 |
| Decapoda | | | | | | | | | | | | | |
| *Cambarus propinquus* .. ... | 1 | | | 1 | | | | | | | | | 2 |
| Amphipoda | | | | | | | | | | | | | |
| *Gammarus fasciatus* . | | | | | | | | | | | | | 1 |
| *Hyalella knickerbockeri* | | 6 | 12 | 1 | 1 | | 4 | 4 | 18 | | | | 61 |
| Isopoda | | | | | | | | | | | | | |
| *Asellus communis* . | 1 | | | 1 | | | | | | | | | 2 |
| Ephemerida | | | | | | | | | | | | | |
| *Cænis* species, nymph | | | | | | 1 | | | | | | | 1 |
| *Hexagenia* species, nymph | | | | | | | 6 | | 1 | | | | 7 |
| Trichoptera | | | | | | | | | | | | | |
| *Agraylea multipunctata* | | | | | | 2 | | | | | | | 2 |
| *Helicopsyche borealis* . | 4 | | 8 | 5 | 1 | | 9 | | 1 | | | | 28 |
| *Limnephelid* larva . | | | 1 | | | | | | | | | | 1 |
| *Neophylax* species | 1 | | | | | | | | | | | | 1 |
| Diptera | | | | | | | | | | | | | |
| *Ablabesmyia* species. | | | | | | 1 | | | | | | | 1 |
| *Chironomus* species | 1 | 3 | 9 | 5 | 5 | | x | | 6 | 1 | | | 31 |
| *Palpomyia*, sens lat | | 4 | 1 | | | [illegible] | | | | | | | 7 |
| *Tanytarsus* species | | | | | | | x | | | | | | x |
| Total of x . | | | | | | | 44 | | | | | | 44 |
| Total associated animals | 9 | 20 | 85 | 43 | 7 | 41 | 90 | 7 | 53 | 1 | 0 | 0 | 355 |
| Total animal life | | | | | | | | | | | | | 661 |

. NOTE — Total of x signifies that the material examined contained several species which were not separated in the identification, hence the total is given for the entire number of species present mollusks represent about a third of the entire population in individuals while on gravel bottoms they are relatively more abundant, the numbers of mollusks and associated animals being about even. This greater abundance of animals on gravel bottoms is probably due to a greater variety of physical conditions in this habitat, permitting such animals as the small bivalves to obtain a foothold, the gravel areas containing 8 species of Sphæriidæ which cannot thrive on the pure boulder habitats. The boulder bottom area is on the whole much poorer in species as well as individuals than is the gravel bottom, the respective number of molluscan species being 13 and 25, or a difference of nearly 50 per cent. It is noteworthy that the same species are dominant in both areas, which really provide the same kind of a habitat, a stony substratum upon which the mollusks may cling. *Goniobasis livescens, Galba catascopium,* and *Physa warreniana* are the dominant species on the boulder bottoms, and *Sphærium vermontanum, Amnicola oneida, Galba catascopium, Physa warreniana,* and *Planorbis parvus* are dominant species on the gravel bottoms. The other species present, which are mostly attendant forms, are not conspicuous by their abundance in individuals.

Among the associated animals, the oligochæte family Naididæ, the spiral caddis-fly larva *Helicopsyche,* and the amphipod *Hyalella* are the dominant forms as regards number of individuals on the boulder bottom; while Naididæ, *Helicopsyche, Hyalella,* and chironomid larvæ are the dominant forms on the gravel bottom. Much of the sameness of these two habitats, especially as regards the associated animals, is due to the presence of filamentous algæ, principally *Spirogyra, Œdogonium,* and *Cladophora,* which provide a uniform habitat on both boulder and gravel bottoms. The oligochæte worms, chironomid larvæ, Cladocera, and Amphipoda, all inhabit this vegetation as do also *Amnicola,* some *Planorbis,* and young *Galba catascopium.* The decrease in the number of dominant species, *Goniobasis* and *Galba,* in the gravel area, and the increase in *Amnicola* and *Planorbis* is to be especially noted. Corresponding differences in the complexion of the two areas as regards the associated animals will also be noted in the tables.

FIG. 25. Invertebrate animals of a 16 square inch unit on sand bottom, Habitat No. xii, Field No. 763. Note the dominance of *Amnicola*, and the masses of algæ.

If we select certain groups or species as characteristic of these bottom areas, we would select for the boulder areas *Goniobasis, Galba, Physa* (all in the adult stage), *Cambarus, Heptagenia, Helicopsyche,* and *Psephenus.* The gravel areas have about the same characteristic animals with the addition of *Sphærium vermontanum.* If a single species of animal is to be designated as characterizing the stony habitats the gastropod *Goniobasis* is best suited for this purpose, and the community might be called a *Goniobasis community,* or if it be thought advisable to add an associated animal, a *Goniobasis-Helicopsyche community.*

Many small fish were noted in the boulder-gravel habitats, especially *Fundulus diaphanus,* and they appear to afford good feeding grounds, especially in calm weather, for many young fish and minnows, even in water but a few inches deep.

**Life on the Sand Bottom.** The unit area examined on sand bottoms was approximately 100 square cm. or 16 square inches. Material was collected from 143 such unit areas, the total molluscan life contained therein being 2,361 individuals and the total associated animal life 2,532 individuals, the averages being 16.51 and 17.7 per unit. There are estimated to be 85 acres of sand bottom in Lower South Bay and on the basis of this area and of the averages for mollusks and associated animals, there are 550,169,334 mollusks and 590,024,120 associated animals, or a total of 1,140,193,454 individuals on the bottom of this area.* A comparison with the rocky bottom shows that life is more than twice as abundant on the sand as upon the gravel and boulder bottoms combined and almost twice as abundant as on the gravel area alone. (See figures 25–30 for illustrations of the animal life of sand bottoms.)

A study of Table No. 18 shows that the mollusks (2,361) total but little less than the associated animals (2,532). Seven

* The computations for the sand bottom are as follows: 43,560 × 144 = 6,272,640 square inches in one acre; × 85 = 533,174,400 square inches in 85 acres; ÷ 16 = 33,323,400 unit areas in 85 acres; × 16.51 mollusks per unit area = 550,169,334 mollusks. 33,323,400 × 17.7 associated animals per unit area = 590,024,120 associated animals + 550,169,334 mollusks = 1,140,193,454 total animal population on 85 acres of sand bottom.

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FIG. 26. Invertebrate animals of a 16 square inch unit on sand bottom, Habitat No. xxv, Field No. 808. The small number of mollusks present in this dredging is noteworthy.

| xxiii | cxxiv | cxxv | cxxvi | cxxvii | cxxix | Total |
|---|---|---|---|---|---|---|
| 019 | 1020 1021 | 1022 | 1023–1035 | 1026 | 1025 | ...... |
| 150 | 30 | 50 | 25 | 150 | 200 | ...... |
| 3 | 2 | 4½ | 3 | 4½ | 4 | ...... |
| 4 | 2 | 4 | 1 | 3 | 4 | 143 |
| .... | ...... | ...... | ...... | ...... | ...... | ...... |
| .... | ...... | ...... | ...... | ...... | ...... | ...... |
| .... | ...... | ...... | ...... | ...... | ...... | ...... |
| .... | ...... | ...... | ...... | ...... | ...... | ...... |
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| .... | ...... | ...... | ...... | ...... | ...... | ...... |
| .... | ...... | ...... | ...... | ...... | ...... | ...... |
| .... | ...... | ...... | ...... | ...... | ...... | ...... |

## Table No. 18. Number of Animals on Sand Bottom

| Habitat numbers | ix | xi | xii | xiii | xvii | xviii | xxiii | xxv | xxvi | xxvii | xxx | xxxi | xxxii | xxxiii | xxxiv | xxxv | xxxvii | xxxviii | xlix | l | lvi | lxi | lxiv | lxv | lxviii | lxix | xcvii | xcviii | xcix | c | cii | cviii | cxiv | cxviii | cxix | cxx | cxxi | cxxii | cxxiii | cxxiv | cxxv | cxxvi | cxxvii | cxxix | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Field numbers | 747-750 | 754-759 | 763-767 | 858 | 780-783 | 784-788 | 803 | 808-810 | 811-814 | 795-798 | 820-823 | 824-826 | 827-831 | 836-841 | 842-843 | 1051 | 844-845 | 846-848 | 870-881 | 882-884 | 889-893 | 900 | 955 | 904-913 | 915 | 916 | 974-975 | 976-977 | 978 | 979-980 | 984-985 | 999 | 1009-1010 | 1013 | 1014 | 1015 | 1016-1017 | 1018 | 1019 | 1020-1021 | 1022 | 1033-1035 | 1026 | 1025 | |
| Distance from shore (feet) | 100 | 100 | 50 | 10 | 50 | 50 | 30 | 50 | 40 | 30 | 25 | 50 | 25 | 50 | 10 | 250 | 300 | 100 | 25 | 25 | 20 | 25 | 5 | 100 | 20 | 50 | 200 | 400 | 200 | 150 | 300 | 5 | 6 | 50 | 100 | 200 | 400 | 300 | 150 | 30 | 50 | 25 | 150 | 200 | |
| Depth of water (in feet) | 4 | 4½ | 3½ | 1½ | 3 | 3 | 3½ | 3½ | 3 | 3 | 3 | 4 | 2 | 3½ | 1½ | 4 | 6 | 3 | 3 | 3½ | 1½ | 1½ | 1 | 2 | 1½ | 2 | 3 | 4 | 3 | 3 | 4 | 3 | 1½ | 3 | 2 | 3 | 3½ | 6 | 3 | 2 | 4½ | 3 | 4½ | 4 | |
| Number of units (16 sq. in.) | 4 | 6 | 5 | 5 | 4 | 5 | 1 | 3 | 4 | 3 | 4 | 3 | 5 | 6 | 1 | 1 | 2 | 3 | 3 | 3 | 13 | 3 | 1 | 5 | 1 | 1 | 2 | 3 | 1 | 2 | 4 | 1 | 5 | 3 | 2 | 3 | 4 | 1 | 4 | 2 | 4 | 1 | 3 | 4 | 143 |
| Figures of animal life | | | 25 | | | | | 26 | | 27 | | | | | | 28 | | | | | | | | | | | 29 | | | | 30 | | | | | | | | | | | | | | |
| Algae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Aphanothece saxicola* | | | | | | | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | x | | | | | | | | | | |
| *Chara* species | | x | | | x | | | | x | x | | x | | | | | | | | | | | | | | | | | | | x | | | x | | | | | | | | | | | |
| *Cladophora fracta* | | | | | | | x | | | | | | | | | | | x | | | | | | | | x | | | | | | x | | x | | | | | | | | | | | |
| *Nitella* species | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | | | | | | | | | | | |
| *Oedogonium crassiusculum* | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Oedogonium faveolens* | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Oedogonium grande angustum* | | | | | | | | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Oedogonium spirale* | | | | | | x | | x | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Oedogonium* species | x | x | x | | x | | x | | | x | | | | x | | x | | x | x | x | x | | | x | | | x | x | x | x | x | | x | | | x | x | | | x | x | x | | x | |
| *Rhamidium ambiguum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | | | | | | | | | | | | | |
| *Rhizoclonium hieroglyphicum* | | | | | | | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Rivularia paradoxa* | | | | | | | | | | | x | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | |
| *Rivularia pisum* | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Spirogyra* species | | | | | | | | | | | | | | | | | | x | x | x | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Tolypothrix limbata* | | | | | x | | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | x | x | | | | | | | | |
| *Tolypothrix tenuis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | | | | | | | | | | | | | |
| Mollusca | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Sphaerium vermontanum* | | 8 | | | | 1 | 1 | | 1 | 1 | | | 12 | 12 | 6 | 122 | | 3 | 2 | | 65 | 13 | | 6 | 8 | | 1 | 9 | 9 | 10 | 29 | 4 | 15 | 38 | | 26 | 11 | | 2 | 8 | 5 | | 3 | | 458 |
| *Musculium transversum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 1 | | | | | | | | | | | | 3 |
| *Musculium* species | | | | | | 2 | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 |
| *Pisidium abditum* | | | | | | | | | | | | | | | | | | | | | | | | | 3 | | | | | 2 | | | | | | | | | | | | | | | 5 |
| *Pisidium compactum* | | | | | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 |
| *Pisidium compressum* | | | | | | | | 2 | 2 | | | | 2 | 1 | | | | | | | 16 | | | | | 4 | | | | | 4 | | | 1 | | | 1 | | | | 3 | | 1 | | 57 |
| *Pisidium ferrugineum* | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| *Pisidium pauperculum* | | | | | | | | | | | | | | 3 | | | | | | 3 | 1 | | | | | | | | | | | | | | | | | | | | | | | | 7 |
| *Pisidium pusillum simplex* | | | | | | | | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | 4 |
| *Pisidium sargenti* | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| *Pisidium variabile* | | | | | | | | | 4 | | | | 5 | 28 | | | | 2 | | | 15 | | | | 3 | | | | | | | | | | | | 2 | | | | | | | | 59 |
| *Pisidium striatum* | | | | | | | | | | | | | | 11 | | | 2 | 13 | 7 | | | | | | | | | | | | 7 | | | | | | | | | | 6 | | | | 46 |
| *Pisidium* [illegible] | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | 3 |
| *Pisidium* species | | | | | | | | 2 | 18 | 1 | 1 | 22 | | 15 | | 30 | | | 2 | 1 | 13 | 1 | | | | 7 | | | | | 8 | | 6 | | | 1 | 4 | | | | 2 | | | | 134 |
| *Campeloma decisum* | | | | 1 | | | | | | | | | | | | | | | | | 2 | | | 1 | | | | | 2 | | | | | | | | | | | | | | | | 6 |
| *Amnicola lustrica* | 35 | 9 | 14 | | 7 | 21 | | | 3 | 17 | 3 | | | | | 18 | 15 | | | 8 | 19 | | | | | | 10 | | 3 | | 6 | | 14 | | | | 2 | 1 | | | 3 | | | 2 | 267 |
| *Amnicola limosa parvula* | | 19 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 19 |
| *Amnicola* [illegible] | 13 | 9 | 28 | | | 29 | | | 40 | 36 | 5 | 7 | 6 | 221 | 3 | 166 | 5 | 5 | 8 | 11 | 13 | | | | | | 1 | 1 | 1 | 3 | 70 | 9 | 2 | 5 | | | | | | | 3 | | 1 | 1 | 672 |
| *Amnicola walkeri* | | | | | | | | | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 8 |
| *Amnicola lustrica* [illegible] | 1 | | | | 10 | | 13 | | 3 | 4 | 3 | 7 | | 8 | | | 4 | 2 | 1 | 5 | 3 | | | | | | 6 | | | 1 | 6 | | 6 | | | | | | | | | | | | 85 |
| *Bithinia tentaculata* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 3 | | | | | 1 | | | | | | | 5 |
| *Valvata bicarinata normalis* | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| *Valvata tricarinata* | 28 | 1 | 4 | | | 1 | 1 | | | 1 | | 2 | | 1 | | | | | | | 3 | | | | | | 1 | | | | | | | | | | | | | | | | | | 57 |
| *Galba catascopium* | 3 | 35 | 1 | | | 7 | | 2 | 4 | 6 | | 5 | | | | 20 | | | | 9 | 2 | | | | | | 6 | | 1 | 2 | 2 | | 3 | 2 | | | | | | | | | | | 131 |
| *Planorbis antrosus* | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | 4 | | | | | | | | | | | | 13 |
| *Planorbis binneyi* | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Planorbis campanulatus* | 1 | 5 | 5 | 8 | | 1 | 1 | | | | | 1 | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | 23 |
| *Planorbis exacutus* | 6 | 3 | 2 | | 6 | 2 | | | | 2 | 1 | 3 | | 1 | | 2 | 1 | | | 2 | 1 | | | | | | | | | | | | | | | | | | | | | | | | 32 |
| *Planorbis hirsutus* | 7 | 3 | 8 | | 10 | 1 | | 1 | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 31 |
| *Planorbis parvus* | 2 | 3 | 4 | | 23 | 21 | | 7 | 11 | 2 | 1 | 4 | | 7 | | 4 | | | | 6 | 13 | | | | | | 5 | | 1 | | 4 | 3 | 19 | | 13 | | | 1 | | | | | | | 154 |
| *Planorbis trivolvis fallax* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | | | | | | | | | | | | 3 |
| *Physa warreniana* | | | | 1 | | | | | | 1 | | | | | | | 1 | | | | | | | | | | | | 2 | | 1 | | | | | | | | | | | | | | 8 |
| *Physa integra* | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | 5 | 29 | | 17 | | 2 | | | | | | | | 52 |
| *Ancylus parallelus* | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | 2 |
| Total mollusca | 98 | 95 | 69 | 11 | 178 | 95 | 3 | 29 | 96 | 74 | 10 | 53 | 26 | 310 | 9 | 302 | 28 | 25 | 20 | 45 | 183 | 14 | | 7 | 14 | 11 | 35 | 10 | 20 | 18 | 138 | 25 | 107 | 46 | 30 | 27 | 24 | 3 | 28 | 8 | 22 | | 5 | 1 | 2101 |
| Porifera | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Spongilla* species | | | | | | | | | | | | | | | | | | | | | | | | | | | | x | x | | | | | | | | | | | | | | | | |
| Polyzoa | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Plumatella punctata* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | x | | | x | | | |
| Hirudinea | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Glossiphonia complanata* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | 2 |
| *Glossiphonia stagnalis* | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| *Placobdella montifera* | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| *Piscicola* species | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | 1 |
| Oligochaeta | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pristina* species | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Slavina* species | 13 | 27 | 35 | | 4 | 19 | 15 | 2 | 3 | 2 | 14 | | | 10 | 1 | | | 60 | 18 | 2 | 33 | | | | | 4 | 7 | 1 | 3 | 8 | 1 | 3 | 4 | 3 | | | | | 1 | 1 | | | | | 294 |
| Enchytraeidae | | | | | | 1 | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| Naididae | 8 | 38 | 5 | | 12 | 15 | 19 | | 24 | | | | 17 | 16 | | | | 3 | 24 | 2 | 34 | | | | | 27 | 10 | 7 | | 11 | 20 | 1 | 6 | 26 | | | 6 | | | 3 | | | | | 334 |
| Tubificidae | | 2 | | | | | | 1 | 3 | | | | 5 | 5 | | | | | | | 22 | | | | | | | | | | 4 | | | 1 | | 5 | 1 | | | 3 | | | | | 52 |
| Incertae sedis | | | | | | | | 26 | | | 2 | 1 | | | | | | | | | 9 | | | | 1 | | 1 | | | | | | | | | | | | | | | | | | 40 |
| Cladocera | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Acroperus harpae* | 21 | 7 | | | | 1 | | | | 5 | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 35 |
| *Alona quadrangularis* | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Camptocercus rectirostris* | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Chydorus sphaericus* | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Eurycercus lamellatus* | 2 | 9 | | | | 3 | 3 | | | 7 | | | | | | | | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | 29 |
| *Sida crystallina* | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | 2 |
| *Simocephalus serrulatus* | 10 | 16 | 3 | | 24 | | 3 | 1 | | | | | | | | | | 7 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | 60 |
| Copepoda | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cyclops albidus* | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Ostracoda | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cypridae | 5 | 5 | 3 | | 3 | | 10 | 4 | | | | | | | | | 1 | 2 | | 7 | | | | | | | | | | | | | | 1 | | | | | | | | | | | 59 |
| Decapoda | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cambarus immunis* | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Cambarus propinquus* | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Amphipoda | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eucrangonyx gracilis* | | | | | | | | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 |
| *Gammarus fasciatus* | | | | | 1 | | | | | | 1 | | | | | | | | | 22 | | | | | | | | | | | | 2 | | | | | | | | | | | | | 32 |
| *Hyalella knickerbockeri* | 1 | 13 | | | 1 | 2 | 30 | 18 | | 5 | 20 | 6 | 1 | 1 | | 2 | 1 | 2 | 3 | | 8 | | | | | | | | | | 1 | 4 | 57 | 1 | 97 | 2 | 2 | | | | | | | | 28[illegible] |
| Isopoda | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Asellus communis* | | 1 | | | | 2 | | 10 | | | 6 | 1 | | 4 | | | | | | 9 | 3 | | | | | | | | | | | 1 | 1 | | | | | | | | | | | | 39 |
| Ephemerida | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Baetis* species, nymph | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | 4 | | | | | | 2 | | | | | | | | 7 |
| *Hexagenia* species, nymph | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Odonata | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphus spiculus*, nymph | | | | | | | | 2 | | | | | | 1 | | | | | 1 | | | | | | | 1 | | | | | | | | | | | | | | | | | | | 5 |
| Hemiptera | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Corixa* species | | | 1 | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| Trichoptera | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Agraylea multipunctata* | 3 | | 1 | | 6 | 7 | 2 | | | 1 | | | | | | 1 | 1 | 3 | | | 2 | | | | | | | | | | | | | 1 | 2 | | | | | | | | | | 30 |
| *Helicopsyche borealis* | | | | | | | 4 | 1 | 3 | 11 | 6 | | | 12 | | | | 1 | | | | | | | | | | | | | 1 | | | | | | | | | | | | 1 | | 35 |
| *Hydroptila* species | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Leptocerus ancylus* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 | | | | | | | | | | | | | | 6 |
| Leptocerid larvae | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | 3 | | | | | | 3 | | | | 2 | | 9 |
| Limnephilid larvae | | | | | | | | 5 | | | 1 | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 8 |
| *Molanna* species | | | | | | 3 | | 4 | 1 | | | 3 | | | | 1 | | 1 | | 1 | 1 | | | | | | 1 | | | | | | 1 | 4 | | 1 | | | | 3 | | | | | 27 |
| *Oecetis inserta?* | | | | | | | | | | | | | | | | 1 | | | 1 | | 11 | 2 | | | 1 | | | | 2 | | | | 1 | | 2 | | | | | | | | 1 | | 33 |
| *Platyphylax maculipennis* | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | 3 |
| Polycentropid larvae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | 1 | | | 4 |
| Diptera | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Ablabesmyia* species | | x | | | | | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | x |
| *Atherix* species | | | | | | | | | | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | x |
| *Chironomus* species | 4 | x | | | | 3 | | x | x | 20 | x | 7 | x | x | | | 3 | x | x | | x | 1 | | | | 9 | x | 1 | 33 | x | x | | x | x | | x | 2 | | | 5 | x | | 6 | 1 | 113 |
| Dixidae | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Orthocladius* species | | | | | | | | | | | | | | x | | | | | | | x | | | | | | x | | | | | | | | | | | | | | | | | | x |
| *Palpomyia* sens. lat. | 2 | 1 | 1 | | 1 | | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | 2 | | 1 | | | | | | | | | | 11 |
| Tanypinae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | 1 |
| *Tanytarsus* species | | | | | | | | x | x | | x | | x | x | | | | x | x | | x | | | | | | | x | | x | x | | x | x | 2 | x | 33 | | 8 | | x | | | | 12 |
| Total of x | | 15 | | | | | | 28 | 86 | | 9 | | 9 | 21 | | | | 16 | 19 | | 69 | | | | | | 18 | 54 | | 20 | 387 | | 7 | 32 | | 14 | | | | | 80 | | | | 887 |
| Coleoptera | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Berosus peregrinus* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | 1 |
| *Bidessus flaviculus* | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Dineutes assimilis* | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | 2 |
| *Gyrinus affinis* | | | | | | | | | | | | | | | | | | | | | | | 5 | | | | | | | | | | | | | | | | | | | | | | 5 |
| *Gyrinus ventralis* | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Psephenus lecontei*, larva | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Acarina | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Arrhenurus americanus major* | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Arrhenurus*, adults, nymphs | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | 3 |
| *Hydrachna* species | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | | | | | | 1 | | | | 5 |
| *Lebertia* [illegible] | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Limnesia* species | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | 1 |
| *Piona* species | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| Total associated animals | 72 | 135 | 49 | 0 | 54 | 56 | 98 | 111 | 128 | 65 | 61 | 19 | 35 | 74 | 1 | 5 | 7 | 100 | 71 | 44 | 197 | 3 | 0 | 2 | 2 | 41 | 38 | 63 | 35 | 43 | 421 | 11 | 86 | 71 | 109 | 22 | 54 | 12 | 14 | 12 | 84 | 3 | 12 | 3 | 2532 |
| Total animal life | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4633 |

Note.—Total of x signifies that the material examined contained several species which were not separated in the identification, hence the total is given for the entire number of species present.

species of mollusks out of 33 make up 76.07 per cent (1,796 individuals) of the total number. These are *Sphærium vermontanum* (458), *Amnicola* (four species, 941 individuals), *Galba catascopium* (133 individuals), and *Planorbis parvus* (154 individuals). Two species of *Amnicola* make up the greater part of the number of that genus (947 individuals). The *Galba* are all young, and probably do not live in this habitat when adult, seeking the rocky and gravelly shores when approaching maturity.

As Petersen has pointed out ('13, pp. 4–5) some of the animals occurring in quantitative collections are seasonal, being present in abundance at one time and wholly or partially wanting at another time. *Galba* and *Physa* are examples of this seasonal occurrence of species, living in the algæ of the bottom when young and immature and seeking the rocky or gravelly shores when approaching maturity. Therefore, the characteristic species of mollusks on the sand bottom are *Sphærium vermontanum, Amnicola oneida, bakeriana,* and *bakeriana nimia,* and *Planorbis parvus,* five species. It should perhaps be called a *Sphærium-Amnicola community.* Though not found in any number, the gastropod *Campeloma* is very characteristic of the sand bottom, not occurring elsewhere except on a clay bottom in several habitats. The large number of *Pisidium,* 11 species, is noteworthy.

When the associated animals are considered a few striking features are apparent in the table. Oligochæte worms make up 28.55 per cent of the total number (723) and chironomid larvæ 41.55 per cent (1,052). The large number of amphipods, of which *Hyalella* is the most abundant, and the number of species (7) and individuals (138) of Cladocera is noteworthy. Many of these animals are seasonal and would not occur in such numbers at other times of the year. Such are the dipterous and trichopterous larvæ, and certain other insect larvæ and nymphs. Earlies in the year the May-fly nymphs are probably of much greater abundance, judging by the heavy flights of adult May-flies observed in June. At the time of year in which the present studies were made (July) the oligochæte worms and chironomid larvæ are the characteristic species of associated animals as regards numbers. The im-

FIG. 27. Invertebrate animals of one 16 square inch unit on sand bottom, Habitat No. xxvii, Field No. 797. Mollusks, especially *Amnicola,* are the dominant or principal animals present.

TABLE No. 19. NUMBER OF ANIMALS ON CLAY BOTTOM

| Habitat numbers | li | lv | lviii | lix | lx | lxii | lxiii | lxvi | lxvii | lxx | lxxi | lxxii | lxxiii | lxxiv | lxxv | lxxvi | lxxvii | lxxviii | lxxix | lxxx | lxxxi | lxxxii | lxxxiii | lxxxiv | lxxxv | cvii | cx | cxii | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Field numbers | 911 | 910 | 899 | 912 | 908–909 | 901 | 902–903 | 905 | 906–907 | 917 | 918–919 | 920 | 922 | 921 | 923 | 924–925 | 926–927 | 928 | 929–931 | 932–934 | 935–936 | 937 | 938 | 939–941 | 942–943 | 1000–1001 | 993–997 | 1004 | |
| Depth of water (in feet) | 3 | 2 | 4½ | 4½ | 5½ | 2½ | 3½ | 5 | 5 | 3½ | 4 | 5 | 4 | 1½ | 4½ | 5 | 2 | 3 | 4 | 5 | 5½ | 5 | 2½ | 4 | 3 | 2 | 4 | 1½ | |
| Distance from shore (feet) | 75 | 3 | 200 | 250 | 400 | 75 | 300 | 300 | 300 | 100 | 200 | 500 | 300 | 20 | 300 | 800 | 75 | 200 | 400 | 600 | 700 | 500 | 100 | 400 | 200 | 30 | 10 | 5 | |
| Number of units (16 sq. in.) | 1 | 1 | 5 | 1 | 2 | 1 | 8 | 1 | 3 | 2 | 2 | 3 | 3 | 1 | 5 | 4 | 2 | 4 | 3 | 4 | 3 | 3 | 3 | 5 | 2 | 6 | 7 | 1 | 85 |
| Figures of animal life | | | | | | | | | | | 31 | | | | 32 | | | | | | | | | | | | 33 | | |
| **Algæ** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Chara* | x | | x | x | | | | | | | x | | | | | | | | | | | | x | | x | x | | | |
| *Cladophora fracta* | x | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | |
| *Microcoleus lacustris* | | | | | | | | | | | | | | | | | | | | x | | | | | | | | | |
| *Mougeotia americana* | | | | | | | | | | | | | | | | | | | x | | | | | | | | | | |
| *Mougeotia gracillima* | | | | | | | | | | | | | | | | | | | x | | | | | | | | | | |
| *Nitella* | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | |
| *Œdogonium oblongum majus* | | | | | | | | | | | | | | | | | | | x | | | | | | | | | | |
| *Œdogonium* species | | | x | x | x | | | | x | | | | | | x | | | | x | | | x | | x | x | | x | x | |
| *Rivularia paludosa* | | | | | | | | | | | | | | | | | | | x | | | | | | | | x | | |
| *Rhizoclonium hieroglyphicum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | x | |
| *Rhizoclonium* species | | | | | | | | | | | | | | | | | | | | | x | | x | | | | | | |
| *Scytonema crispus* | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | |
| *Spirogyra* species | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [illegible] | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | |
| *Tolypothrix limbata* | | | | | | | | | | | | | | | | | x | x | | | | | | | | | | | |
| *Tolypothrix tenuis* | | | | | | | | | | | | | x | | | | x | | | | | | | | | | | | |
| **Mollusca** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Sphærium vermontanum* | 3 | | | | | | 8 | 4 | 3 | | | | | 3 | | | | | | | | | | | | 1 | | | 22 |
| *Musculium* species | | 1 | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | 2 |
| *Musculium transversum* | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 7 | | 9 |
| *Musculium truncatum* | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| *Pisidium abditum* | | 2 | | | | | | | | | | | | 1 | 1 | | | | | | | | | | | | | | 4 |
| *Pisidium compressum* | 2 | | | | | | | | 7 | | | | 1 | | | 2 | | | | | 1 | | | 2 | | | | | 15 |
| *Pisidium ferrugineum* | | | | | | | | | | | 4 | | | | 3 | 3 | | 2 | 1 | 4 | | | | | | | | | 17 |
| *Pisidium scutellatum* | | | | | | | | | 4 | | | | | | | | | 1 | | | | | | | | | | | 5 |
| *Pisidium* s. *cristatum* | 3 | | | | | | | | 2 | | | | 1 | | | | | | | | | 5 | | 3 | | | | | 14 |
| *Pisidium splendidulum* | | | | | | | | | 6 | | | | | | | | | | | | | | | | | | | | 6 |
| *Pisidium variabile* | | | | | | | | | 1 | | | | | | | 2 | | 1 | | | | | | | | | | | 4 |
| *Pisidium* species | 8 | | | | 2 | | | 1 | 11 | 1 | | | 2 | | | | | 5 | 2 | | 1 | 1 | | 1 | 6 | | | | 41 |
| *Campeloma decisum* | | | | | | 2 | 3 | 1 | 3 | | | | | | | | | | | | | | | | | 1 | | | 10 |
| *Bythinia tentaculata* | | | | | | | | | | | | | | | | | | | | | | | | | | | 13 | | 13 |
| *Amnicola bakeriana* | | | | | 27 | | | | | 7 | 6 | | | | 3 | 11 | | | | 3 | | | | 4 | 3 | | 2 | 1 | 67 |
| *Amnicola oneida* | | | | | 9 | | | 1 | | 70 | 70 | 10 | 8 | | 5 | 12 | | 1 | 3 | 2 | 4 | 4 | 3 | | 21 | | 5 | 1 | 238 |
| *Amnicola bakeriana nimia* | | | | | 4 | | | | | 14 | 8 | 1 | 3 | | | | | 1 | | | 4 | 2 | 10 | 5 | | 1 | 2 | 1 | 56 |
| *Amnicola clarkei* | | | | | | | | | | | | | | | | | | | | 4 | | | | | | | | | 4 |
| *Valvata tricarinata normalis* | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Valvata tricarinata* | | | | | 1 | | | | 1 | | | | | | | | | | | | | | | | | | | | 2 |
| *Galba catascopium* | 3 | | | | 3 | | | | | 1 | | | | | | 3 | | | | 1 | | | 1 | 1 | 3 | | | | 16 |
| *Planorbis antrosus* | | | | | | | | | | 1 | 4 | | | | | | | | | | | | | | | | | | 5 |
| *Planorbis binneyi* | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | 1 |
| *Planorbis campanulatus* | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | 1 | | 2 |
| *Planorbis exacuous* | | | | | 1 | | | | | 2 | 1 | | | | | 3 | | 2 | | | | | 1 | | | | | | 10 |
| *Planorbis parvus* | | | | | | | | | | 4 | 5 | | | | | | | | | | | | 4 | | 3 | | 10 | 1 | 27 |
| *Planorbis trivolvis fallax* | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 |
| *Physa warreniana* | 2 | | | | | | | | | | | | | | | | | 1 | | | | | | | | | 18 | | 21 |
| *Physa integra* | | | | | | | | | | | | | | | | | | | | | | | | | | 10 | 3 | | 13 |
| *Ancylus parallelus* | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | 2 |
| Total Mollusca | 22 | 3 | | | 47 | 2 | 11 | 7 | 38 | 131 | 100 | 11 | 15 | 4 | 13 | 30 | | 14 | 6 | 15 | 10 | 12 | 19 | 16 | 16 | 15 | 62 | 5 | 629 |
| **Porifera** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Spongilla fragilis* | | | | | | | | | | | | | | | | x | | | x | x | | x | | | | | | | |
| **Polyzoa** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Plumatella punctata* | | | | x | x | | | | | | | | | | | | | | | | | | | | | | | | |
| **Turbellaria** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Planaria dorotocephala* | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | 2 |
| **Hirudinea** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Erpobdella punctata* | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | 2 |
| *Glossiphonia complanata* | | | | | | | | | | | | | | | | | | | | 1 | | | 1 | | | | | | 2 |
| *Glossiphonia stagnalis* | | | | | | | | | | | 1 | | | | | | | | | | | 1 | | | | | | | 2 |
| **Chætopoda** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Naidium* species | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | 1 |
| *Pristina* species | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 |
| [illegible] | | | | | 3 | | | | | 13 | | 4 | | | 8 | 1 | | | 2 | 2 | 36 | 2 | | | 1 | | 2 | 1 | 92 |
| Enchytræidæ | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Naididæ | 59 | 1 | | | 1 | | | | | 12 | | | | | 5 | 2 | | | 2 | | | 1 | | | 7 | | 4 | 1 | 97 |
| Tubificidæ | 10 | 1 | | | | | | | 15 | | | | | | | | | | 1 | 1 | 2 | 2 | 1 | 1 | 1 | | | | 35 |
| Incertæ sedis | | | | | | | | | | | | | | | | | | | | 5 | | | 6 | | | | | | 11 |
| **Cladocera** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Acroperus harpæ* | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | 1 |
| *Eurycercus lamellatus* | | | | | | | | | | 3 | | | | | | | | | | | | | 2 | | | | | 3 | 8 |
| *Sida crystallina* | | | | | | | | | | 2 | 4 | | | | | | | | | | | | | | | | | 2 | 8 |
| *Simocephalus serrulatus* | | | | | | | | | | 7 | | | | | | | | | 2 | | | | | | | | | | 9 |
| *Simocephalus vetulus* | | | | | | | | | | 14 | | | | | | | | | | | | | | | | | | | 14 |
| **Copepoda** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cyclops albidus* | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | 1 |
| **Ostracoda** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cypridæ | | | | | | | | | | | | | | | | | | | 4 | | | | | | | | | 1 | 5 |
| **Amphipoda** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eucrangonyx gracilis* | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| *Hyalella knickerbockeri* | 5 | 4 | 2 | | 2 | | | | | 30 | 34 | | 9 | | 32 | 10 | 48 | 3 | 14 | 2 | 1 | | 30 | 10 | 4 | | 3 | 24 | 279 |
| **Isopoda** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Asellus communis* | 1 | | | | | | | | | | 71 | | 21 | | 28 | 27 | 93 | 17 | 30 | 66 | 18 | 21 | 25 | 13 | | | | | 132 |
| **Ephemerida** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Bætis* species, nymph | | | | | | | | | | | | 1 | | | | 1 | | | | | | | | | | | | | 2 |
| **Odonata** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphus spicatus*, nymph | | 1 | | | | | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 3 |
| **Neuroptera** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Sialis infumata*, nymph | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | 1 |
| **Hemiptera** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gerris marginatus* | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| **Trichoptera** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Leptocera* [illegible] | 1 | 2 | | | | | | | | 51 | 52 | | | | 15 | | | | | | | | 6 | | 7 | | 9 | 1 | 145 |
| *Helicopsyche borealis* | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 | 2 |
| *Hydroptila* species | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 |
| *Ithytrichia* species | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Leptocella* species | | | 1 | | | | | | | | 2 | | | | | | | | | | | | | | | | | | 3 |
| *Molanna* species | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | 2 |
| *Œcetis inconspicua* | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 2 | | 3 |
| *Phryganea* species | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | 2 |
| **Lepidoptera** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nymphula* species, larva | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| **Diptera** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Tlabesmyia* species | | | | | | | | | | | 1 | | | | | | | | | | x | | 2 | | | | | | 3 |
| *Chironomus* species | x | 1 | 5 | | 2 | | | x | 6 | 7 | 4 | | 2 | x | 6 | 5 | | 4 | | 3 | x | 6 | 2 | 23 | 17 | 1 | 3 | | 91 |
| *Palpomyia* species | x | | | | | | | | | 2 | 4 | | | | 2 | | | | | | 3 | | | | | 1 | 4 | | 16 |
| *Tanytarsus* species | x | | | | | | | x | x | | | 1 | | x | | | | | | | | | | | | 1 | | | 2 |
| Total of x | 15 | | | | | | | 4 | 64 | | | | | 6 | | | | | | | 10 | | | | | | | | 99 |
| **Coleoptera** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Elmis bivittatus* | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Gyrinus* species, larva | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | 1 |
| *Dryops* species, larva | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| **Acarina** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Arrhenurus marshalli* | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 |
| *Arrhenurus*, adult, nymph | | | | | | | | | | 1 | | | | | | 1 | | | 1 | | | | 1 | | | | | | 4 |
| *Frontipoda americana* | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | 1 |
| *Limnesia* species | | | | | | | | | 1 | | 1 | | | | | | | | | | | | | | | | | | 2 |
| *Piona*, adult | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Unionicola* species | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | 1 |
| Total associated animals | 93 | 14 | 8 | 0 | 10 | 1 | 0 | 4 | 80 | 151 | 181 | 6 | 12 | 6 | 98 | 47 | 141 | 26 | 57 | 80 | 80 | 37 | 83 | 54 | 35 | 4 | 31 | 35 | 1397 |
| Total animal life | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2025 |

portance of investigations of this kind at different seasons of the year is thus shown.

There is an increase in number of species from boulder to sand bottom. Thus the boulder bottom contained 13 species of mollusks and 30 associated animals, the gravel bottom 25 species of mollusks and 26 associated animals, and the sand bottom 33 species of mollusks and 61 associated animals. It is noteworthy that the greatest number of species occur where there is a heavy growth of filamentous algæ, principally *Œdogonium* and *Cladophora*, and where these plants are absent little life is found. Thus in Habitat No. 35, where the alga *Œdogonium* occurred in masses, 302 mollusks were found, but in Habitat No. 122, where no algæ was collected, only three mollusks were found. The influence of this plant is at once apparent when fresh material from a unit area is examined. Upwards of seven species of filamentous algæ were collected from the sand bottom, together with a number of the gelatinous blue-green species. A study of the table will bring out many other points which cannot be dwelt upon at length.

**Life on the Clay Bottom.** The unit areas examined on the clay bottoms were the same as on sand bottoms, 16 square inches. The clay bottom is composed of two types of soil, typical clay and a clay more or less mixed with sand of varying degrees of fineness. From the typical clay bottom, material was collected from 88 units (Table No. 19). The molluscan life totalled 629 and the associated animal life 1,397 individuals, the mollusks forming less than a third of the total animal life of 2,026 individuals. Per unit area, the mollusks average 7.14 and the associated animals 15.87, a total of 23.02 individuals per unit area. As there are 87 acres of clay bottom, the total animal population is calculated to be 785,222,404, of which mollusks are 243,766,159 and associated animals 541,456,245.* (See figures 31–33 for illustrations of animal life of the clay units.)

* The computations for the clay bottom are as follows: 43,560 × 144 = 6,272,640 square inches in one acre; × 87 = 545,719,680 square inches in 87 acres; ÷ 16 = 34,107,480 unit areas in 87 acres; × 7.14 mollusks per unit area = 243,766,159 mollusks. 34,107,480 × 15.87 associated animals per unit area = 541,456,245 + 243,766,159 = 785,222,404 total animal population.

FIG. 28. Invertebrate animals of a 16 square inch unit on sand bottom, Habitat No. xxxv, Field No. 1051. Note the great abundance of the bivalve mollusk *Sphærium* and the gastropod *Amnicola*. Associated animals are notably rare.

Table No. 20. Number of Animals on Sandy Clay Bottom

TABLE No. 20. NUMBER OF ANIMALS ON SANDY CLAY BOTTOM

| Habitat numbers | lii | liii | liv | lvii | lxxxvii | lxxxviii | lxxxix | xc | xci | xcii | xciii | xciv | xcv | xcvi | cv | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Field numbers | 885 | 886–888 | 894 895 | 896–898 | 966 967 | 965 | 944–947 | 948–952 | 971–973 | 950 | 957–959 | 962 | 960 961 | 963 964 | 968 | .. |
| Distance from shore (feet) | 30 | 25 | 100 | 100 | 25 | 100 | 50 | 200 | 200 | 300 | 200 | 300 | 250 | 100 | 400 | ... |
| Depth (in feet) | 3 | 2½ | 3 | 3½ | 1½ | 3 | 2 | 3½ | 4 | 5 | 3½ | 5 | 4 | 4 | 6 | ... |
| Number of units (16 sq. in.) | 1 | 4 | 1 | 3 | 3 | 1 | 4 | 7 | 3 | 1 | 3 | 1 | 2 | 2 | 1 | 37 |
| Figures of animal life | | | | | | | | | | | 34 | | | | | |
| Algæ | | | | | | | | | | | | | | | | |
| *Binuclearia tetrana* | | | | | | | | x | | | | | | | | |
| *Calothrix adscendens* | | | | | | | | x | | | | | | | | |
| *Chara* species | | x | x | x | | | | | | | | | | | | |
| *Cladophora fracta* | | x | x | | | | | x | x | x | x | x | x | x | | |
| *Nitella* species | | x | | | | | | | | | | | | | | |
| *Œdogonium crassiusculum* | | | | | | | x | x | | x | x | | | | | |
| *Œdogonium grande angustum* | | | | | | | x | x | | | | | | | | |
| *Œdogonium spirale* | | | | | | | x | x | | | | | | | | |
| *Œdogonium tumidulum* | | | | | | | | x | | | | | | | | |
| *Œdogonium* species | x | x | | x | | | | | | | | x | | x | x | |
| *Spirogyra pratensis* | | | | | | | x | | | | | | | | | |
| *Tolypothrix limbata* | | | | | | | x | | | | | | | | | |
| Mollusca | | | | | | | | | | | | | | | | |
| *Sphærium vermontanum* | | | | 2 | | | | 5 | | | | | | | | 7 |
| *Musculium* species | 5 | 3 | | | | | | | | | | | | | | 8 |
| *Pisidium compressum* | | | | | | | | 1 | | | | | | | | 1 |
| *Pisidium punctatum simplex* | | | | | | | 1 | | | | | | | | | 1 |
| *Pisidium scutellatum* | | 15 | | | | | | | | | | | | | | 15 |
| *Pisidium s. cristatum* | | | | | | | | 1 | | | | | | | | 1 |
| *Pisidium variabile* | | | | | | | 1 | | | | | | | | | 1 |
| *Pisidium* species | | 7 | | | | | 1 | 1 | 1 | | | | | | | 10 |
| *Amnicola bakeriana* | 5 | 15 | | | 1 | 1 | | 9 | 17 | 2 | 3 | 2 | 5 | | 5 | 65 |
| *Amnicola oneida* | 6 | 23 | 1 | 20 | | | 8 | 6 | 7 | | 4 | 1 | | 4 | | 80 |
| *Amnicola bakeriana nimia* | 4 | 15 | | | | | | 11 | | 3 | | | 3 | | 2 | 38 |
| *Valvata tricarinata* | | | | | | | | 13 | 1 | | | | | | | 14 |
| *Galba catascopium* | 7 | 2 | 1 | 2 | | | | 6 | 1 | | 3 | | | | | 22 |
| *Planorbis antrosus* | | | | | | | | | | 4 | | 1 | 1 | | 4 | 10 |
| *Planorbis campanulatus* | | | | | | | | | 4 | | 4 | | | | | 8 |
| *Planorbis exacuous* | | 2 | | | 2 | | | | | 3 | | | | | | 7 |
| *Planorbis hirsutus* | | | | | 2 | | | | 1 | | | | | | | 3 |
| *Planorbis parvus* | 14 | 13 | 1 | 1 | 1 | 2 | | 33 | 2 | 6 | 19 | 2 | 3 | 1 | 11 | 109 |
| *Physa warreniana* | 5 | 1 | | | 3 | | 3 | | | 2 | 1 | | 4 | 2 | | 21 |
| *Ancylus fuscus* | | | | | 2 | | | | | | | | | | | 2 |
| *Ancylus parallelus* | 1 | | | | 6 | | | | | | | | | 1 | | 8 |
| Total Mollusca | 47 | 96 | 3 | 34 | 17 | 3 | 14 | 86 | 34 | 20 | 34 | 6 | 16 | 8 | 22 | 440 |
| Porifera | | | | | | | | | | | | | | | | |
| *Spongilla lacustris* | | | | | | | | x | | | | | | | | |
| Turbellaria | | | | | | | | | | | | | | | | |
| *Planaria maculata* | | | | | | | | | | | 13 | | | | | 13 |
| *Planaria dorotocephala* | | | | | | | | | | | | | 2 | 1 | | 3 |
| Hirudinea | | | | | | | | | | | | | | | | |
| *Erpobdella punctata* | | | | | | | | | | | | | 1 | 2 | | 3 |
| *Glossiphonia fusca* | | | | | 1 | | | | | | | | | | | 1 |
| *Glossiphonia stagnalis* | | | | | 2 | | | | | | | 1 | 4 | 1 | | 8 |
| Oligochæta | | | | | | | | | | | | | | | | |
| *Pristina* species | | | | | | | | | | | | 1 | | | | 1 |
| *Stylaria* species | 10 | | | 16 | | | 2 | 9 | 1 | 2 | 6 | | | 3 | | 49 |
| Enchytræidæ | | | | 1 | | | | | 1 | | | | | | | 2 |
| Naididæ | | | 12 | 23 | | | | | | | 11 | | | 6 | | 52 |
| Tubificidæ | | 2 | 1 | | | | | 6 | | | | | | | | 9 |
| Incertæ sedis | | | | | 2 | | 8 | | 3 | | | | | | | 13 |
| Cladocera | | | | | | | | | | | | | | | | |
| *Acroperus harpæ* | | | | | | | | 101 | | | | | | | | 101 |
| *Camptocercus rectirostris* | | | | | | | | 2 | | | | | | | | 2 |
| *Eurycercus lamellatus* | | | | | | | | 2 | | | | | | | | 2 |
| *Pleuroxus denticulatus* | | | | | | | | 1 | | | | | | | | 1 |
| *Sida crystallina* | | | | | | | | 1 | | | | | | | | 1 |
| *Simocephalus serrulatus* | | | | | | | | 2 | 1 | | 1 | | | 1 | | 5 |
| Copepoda | | | | | | | | | | | | | | | | |
| *Cyclops albidus* | | | | | | | | 2 | | | | | | | | 2 |
| Amphipoda | | | | | | | | | | | | | | | | |
| *Hyalella knickerbockeri* | 5 | 6 | 1 | 5 | 1 | 5 | 16 | 16 | 7 | 1 | 32 | 3 | 20 | 15 | 6 | 142 |
| Isopoda | | | | | | | | | | | | | | | | |
| *Asellus communis* | 2 | 12 | | | 1 | 1 | 1 | | 2 | | | 6 | 7 | | | 32 |
| Ephemerida | | | | | | | | | | | | | | | | |
| *Baetis* species, nymph | | | | | | | | 1 | | | | | | | | 1 |
| Odonata | | | | | | | | | | | | | | | | |
| *Enallagma*, species, nymph | | | | | | | | | 1 | | | | | | | 1 |
| *Gomphus spicatus*, nymph | | 2 | | | | | 1 | | | | | | | | | 3 |
| Hemiptera | | | | | | | | | | | | | | | | |
| *Corisa* species, nymph | | | | | | | | | | | 1 | | | | | 1 |
| Trichoptera | | | | | | | | | | | | | | | | |
| *Agraylea multipunctata* | | | 2 | 9 | | | 2 | | | | 3 | | | | | 16 |
| *Helicopsyche borealis* | | 1 | | | | | | | 1 | | | | | | | 2 |
| *Hydroptila* species | | | | | | 1 | | | | | | 2 | 3 | 1 | | 7 |
| *Leptocerid* larvæ | | 3 | | | | | | | | | | | | | | 3 |
| *Molanna* species | | | | | | | 1 | | | | | | | | | 1 |
| *Œcetis incerta* | | | | 1 | | 1 | | | | | 1 | | | | | 3 |
| Lepidoptera | | | | | | | | | | | | | | | | |
| *Nymphula maculalis*, larvæ | | | | | | | | | | | | | 1 | | | 1 |
| *Nymphula* species, larvæ | | | | | | 1 | | | | | | | | 2 | 1 | 4 |
| Diptera | | | | | | | | | | | | | | | | |
| *Ablabesmyia* species | | | | | | | x | | | | | | 1 | x | | 1 |
| *Corynoneura* species | | | | | | | | | | | x | | | x | | x |
| *Chironomus* species | | 2 | x | x | 1 | | x | x | | 11 | x | 3 | 14 | x | 4 | 35 |
| *Palpomyia*, sens lat. | | | | | | | | 1 | | | 3 | | 3 | x | | 7 |
| Tabanidæ | | | | | | | 1 | | | | | | | | | 1 |
| *Tanytarsus* species | | | x | x | | | | x | | | | | | | | x |
| Tipulid larva | | | | | 1 | | | | | | | | | | | 1 |
| Totals of x | | | 25 | 10 | | | 6 | 41 | | | 25 | | | 16 | | 123 |
| Coleoptera | | | | | | | | | | | | | | | | |
| *Elmis bivittatus* | | | | | | | | | | | 1 | | | | | 1 |
| *Dibolia borealis* | | | | | | | | | | | 1 | | | | | 1 |
| *Gyrinus* species, larvæ | | | | | | | | | | | 3 | | | | 1 | 4 |
| Acarina | | | | | | | | | | | | | | | | |
| *Arrhenurus* species | | | | | | | | | | | | 1 | | | | 1 |
| *Hygrobates* species | | | | | | | | 1 | | | | | | | | 1 |
| *Limnochares aquaticus* | | | | | 1 | | | | | | | | | | | 1 |
| Total associated animals | 17 | 28 | 44 | 65 | 10 | 9 | 39 | 186 | 16 | 14 | 101 | 17 | 56 | 48 | 12 | 662 |
| Total animal life | | | | | | | | | | | | | | | | 1102 |

NOTE.—Total of x signifies that the material examined contained several species which were not separated in the identification, hence the total is given for the entire number of species.

On the sandy clay bottom 37 unit areas were examined, containing 440 mollusks and 662 associated animals, or an average of 11.89 mollusks and 17.89 associated animals per unit area. With this average as a basis, the five acres of this bottom contain 23,308,738 mollusks and 35,069,938 associated animals, or a total animal population of 58,378,676.* Combining this result with the total population of the clay bottom we have a total calculation of 843,601,080 animals on the 92 acres of bottom in which clay is the chief material of the soil. A comparison of life per unit area of the sand habitats with the clay and sandy clay habitats shows that the clay bottom contains 33 per cent less of animal life than the sand bottom supports. The sandy clay bottom is 13 per cent richer in animal life than the clay bottom (see figure 34 for the life of the sandy clay unit).

A study of Tables Nos. 19 and 20, in which the animals of the clay and sandy clay bottoms are plotted, shows that on the sandy clay bottom the mollusks form 39.9 per cent of the total amount of life. Of the mollusks *Amnicola* makes up 43.6 per cent and *Planorbis parvus* 24.7 per cent. These four species represent a total of 68.4 per cent, the other 17 species forming but 31.6 per cent of the total mass of individuals. Among the associated animals, oligochæte worms make up 19 per cent, dipterous larvæ 25.3 per cent, and crustaceans 43.3 per cent. *Hyalella* alone forms 21.4 per cent of the associated animals. The characteristic species of the sandy clay bottom are *Amnicola* and *Planorbis parvus* among the mollusks and *Hyalella* and chironomid larvæ among the associated animals. The Crustacea as a whole may be said to dominate, forming 43.3 per cent of the total number. The presence of filamentous algæ (*Œdogonium, Cladophora,* etc.) is here a large factor in providing food and shelter for the great number of individuals present (see Embody, '12, p. 4).

* The computations for the sandy clay bottom fauna are as follows: 6,272,640 × 5 = 31,363,200 square inches in five acres ÷ 16 = 1,960,200 unit areas in five acres; × 11.89 mollusks per unit area = 23,308,738 mollusks. 1,960,200 × 17.89 associated animals per unit area = 35,069,938 + 23,308,738 = 58,378,676 total animal population.

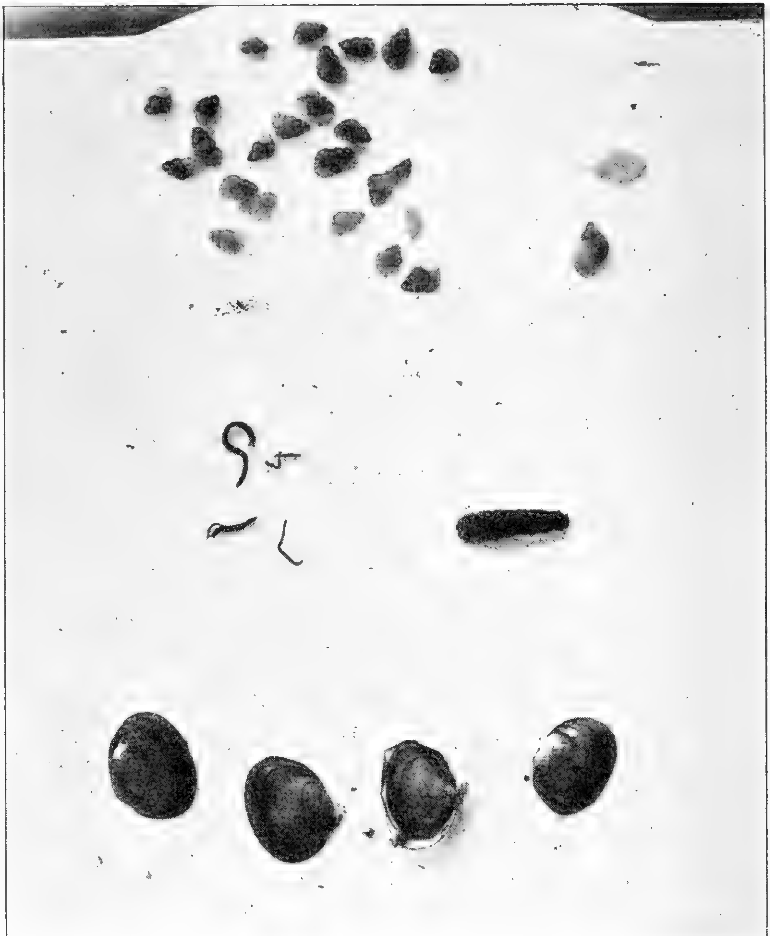

FIG. 29. Invertebrate animals of a 16 square inch unit on sand bottom, Habitat No. xcvii, Field No. 975. *Amnicola* is the principal species represented.

On the typical clay bottom the mollusks comprise but 31 per cent of the total life present, a smaller percentage than for any bottom habitat except that of boulder. Among the mollusks, *Amnicola* is again the characteristic group of species, *Amnicola oneida* providing 37.8 per cent of the total animal life. Eight species of *Pisidium* total 16.8 per cent. *Campeloma* is a mollusk characteristic of a clay or sand bottom, but does not occur in large numbers of individuals. Among the associated animals several groups include large percentages; Oligochæte worms 17, amphipods 20, isopods 30.8, and dipterous larvæ 15.1. The crustaceans total 54.1 per cent, a somewhat larger ratio than that of the sandy clay habitat (43.3 per cent). The filamentous algæ *Œdogonium, Cladophora,* and *Spirogyra* are a factor here as on the sandy clay bottom. The characteristic animals of the clay bottom are *Amnicola, Hyalella,* and *Asellus.*

**Life on the Mud Bottom.** The mud bottoms may be divided into three divisions, 1, within the 6-foot contour; 2, between the 6-foot and 12-foot contours; and 3, between the 12-foot and 18-foot contours.

1. *Shore to 6-foot Contour.* Twenty-seven unit areas (Table No. 21) were examined from the shallow water mud bottom area, a total of 525 mollusks and 465 associated animals being collected, or an average of 19.44 mollusks and 17.22 associated animals per unit area and a total animal population of 36.66 individuals per unit area. *This average shows that the mud bottom in shallow water is the richest in animal life, quantitatively, the sand bottom being second in richness* (average 34.21 individuals per unit area). *Amnicola oneida* and *Planorbis parvus* combined form 51 per cent (31.2 and 19.8 respectively) of the total amount of animal life, while the three species of *Amnicola* and the same of *Planorbis* total 69.1 per cent of the individuals represented by the 26 species of mollusks. Of the associated animals, the isopods form 12.4 per cent and the amphipods 28.3 per cent. The group Crustacea comprises 49.2 per cent of the associated animals. Dipterous larvæ here make up but 17.8 per cent of the total. *Amnicola oneida,*

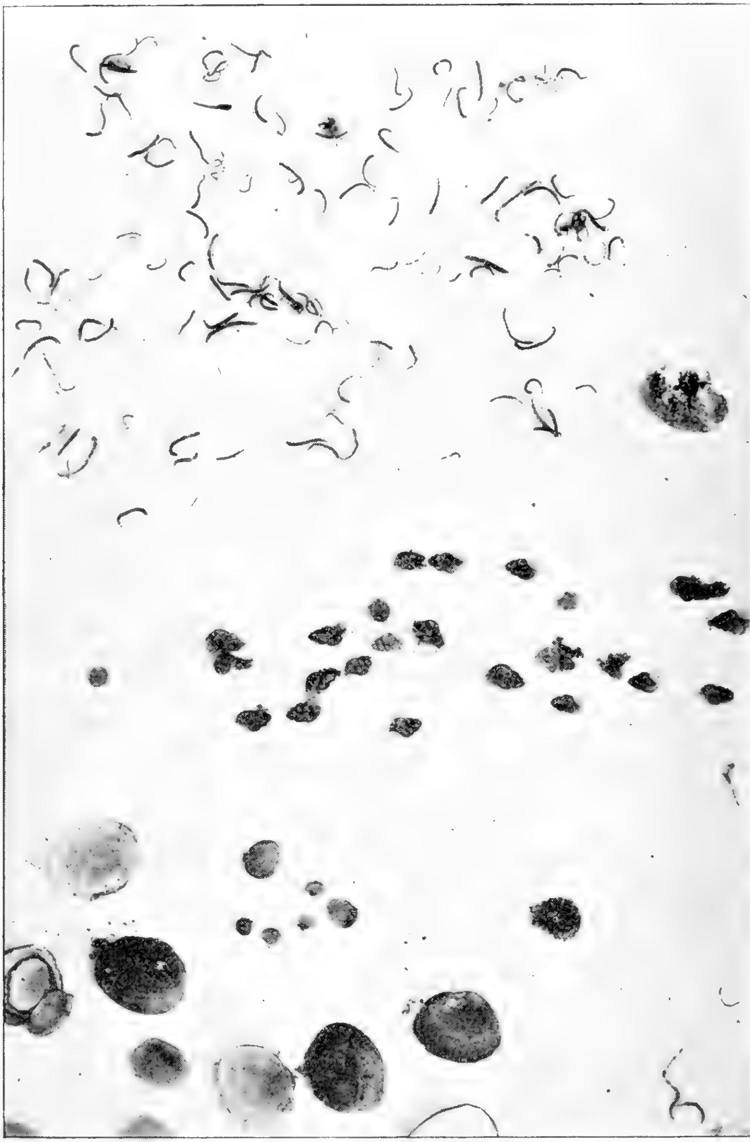

Fig. 30. Invertebrate animals of a 16 square inch unit on sand bottom, Habitat No. cii, Field No. 984. Chironomid larvæ and *Amnicola* are the principal animals present.

TABLE No. 21. NUMBER OF ANIMALS ON MUD BOTTOM

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Gomphus spicatus*, nymph | .... | 1 | .... | .... | .... | .... | | | | |
| Trichoptera | | | | | | | | | | |
| *Agraylea multipunctata* | .... | .... | .... | .... | 3 | 2 | 26 | .... | .... | 31 |
| *Helicopysche borealis* | .... | .... | .... | 3 | .... | .... | .... | .... | .... | 3 |
| *Molanna* species | .... | .... | .... | .... | .... | .... | 4 | .... | .... | 4 |
| *Œcetis incerta* | .... | .... | 1 | .... | .... | .... | .... | 2 | .... | 3 |
| *Platyphylax maculipennis* | .... | .... | 1 | .... | .... | .... | .... | .... | .... | 1 |
| Lepidoptera | | | | | | | | | | |
| *Nymphula* species, larva | .... | .... | .... | .... | .... | .... | .... | 1 | .... | 1 |
| Diptera | | | | | | | | | | |
| *Ablabesmyia* species | .... | .... | .... | x | .... | .... | .... | x | .... | x |
| *Chironomus* species | .... | 3 | 1 | x | .... | 3 | .... | x | .... | 7 |
| *Palpoymia*, larvæ-pupæ | .... | .... | .... | .... | .... | .... | 8 | x | .... | 8 |
| *Tanytarsus* species | .... | .... | .... | .... | 1 | .... | .... | .... | .... | 1 |
| Total of x | .... | .... | .... | 14 | .... | .... | .... | 57 | .... | 71 |
| Coleoptera | | | | | | | | | | |
| *Berosus* species | .... | .... | .... | .... | .... | .... | .... | 1 | .... | 1 |
| *Elmis bivittatus* | .... | .... | .... | 1 | .... | .... | .... | .... | .... | 1 |
| *Haliplus* species | .... | .... | .... | .... | .... | .... | 2 | .... | .... | 2 |
| Acarina | | | | | | | | | | |
| *Arrhenurus superior* | .... | .... | .... | .... | .... | .... | .... | 1 | .... | 1 |
| *Arrhenurus*, adult-immature | .... | .... | .... | .... | .... | .... | 8 | 5 | .... | 13 |
| *Limnesia* species | .... | .... | .... | .... | .... | .... | .... | 3 | .... | 3 |
| *Limnochares aquaticus* | .... | .... | .... | .... | .... | .... | .... | 1 | .... | 1 |
| *Piona* species | .... | 1 | .... | .... | .... | .... | .... | .... | .... | 1 |
| Total associated animals | 31 | 13 | 12 | 20 | 10 | 28 | 233 | 118 | 0 | 465 |
| Total animal life | .... | .... | .... | .... | .... | .... | .... | .... | .... | 990 |

NOTE.— Total of x signifies that the material examined contained several species which were not reported in the identifications, hence the total is given for the entire number of species.

TABLE NO. 21. NUMBER OF ANIMALS ON MUD BOTTOM

| Habitat numbers | xiv | xv | xx | xxiv | xxviii | xxix | xxxvi | cxv | cxvi | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Field numbers | 768–772 | 773 774 | 790–792 | 799 800 | 815–818 | 819 | 832–835 | 1008 | 1011 | ..... |
| Distance from shore (feet) | 125 | 25 | 40 | 150 | 30 | 40 | 10 | 10 | 10 | ..... |
| Depth of water (in feet) | 4½ | 4 | 4 | 5½ | 3½ | 2½ | 1½ | 4 | 6 | |
| Number of units (16 sq. in.) | 5 | 2 | 3 | 2 | 3 | 1 | 6 | 4 | 1 | 27 |
| Figures of animal life | .... | .... | .... | .... | .... | .... | 35 | .... | .... | ..... |
| Algæ | | | | | | | | | | |
| *Cladophora fracta* | .... | .... | .... | x | .... | .... | x | .... | .... | |
| *Coleochæta scutata* | .... | x | .... | .... | .... | .... | .... | .... | .... | |
| *Microspora amœna* | .... | .... | .... | .... | .... | .... | x | .... | .... | |
| *Mougeotia* species | x | .... | .... | .... | .... | .... | .... | .... | .... | |
| *Nitella* species | .... | .... | .... | .... | .... | .... | .... | .... | x | |
| *Œdogonium crassum longum* | .... | .... | .... | .... | x | x | .... | .... | .... | |
| *Œdogonium spirale* | .... | .... | .... | .... | x | x | .... | | | |
| *Œdogonium* species | x | x | .... | x | .... | .... | .... | | | |
| *Rhizoclonium* species | .... | .... | .... | .... | .... | .... | x | | | |
| *Rivularia paradoxa* | .... | .... | x | .... | .... | .... | x | | | |
| *Rivularia pisum* | | | | | x | x | | | | |
| Mollusca | | | | | | | | | | |
| *Sphærium vermontanum* | .... | .... | .... | 2 | .... | 1 | .... | .... | .... | 3 |
| *Musculium* species | 2 | .... | .... | .... | .... | .... | .... | 2 | .... | 4 |
| *Pisidium variabile* | .... | 1 | .... | .... | .... | .... | .... | .... | .... | 1 |
| *Pisidium* species | 3 | 1 | | 2 | | | 2 | | | 8 |
| *Bythinia tentaculata* | | | | | | | | 25 | | 25 |
| *Amnicola bakeriana* | 34 | | | 5 | 2 | 6 | 4 | 9 | 2 | 62 |
| *Amnicola oneida* | 109 | | | 39 | 16 | | | | | 164 |
| *Amnicola bakeriana nimia* | 15 | | | | | | 18 | | | 33 |
| *Valvata bicarinata normalis* | | | | 1 | | | | | | 1 |
| *Valvata tricarinata* | 10 | | | | | | | | | 10 |
| *Acella haldemani* | .... | .... | .... | .... | .... | .... | 4 | .... | .... | 4 |
| *Galba catascopium* | 21 | .... | .... | 2 | .... | .... | .... | 2 | 1 | 26 |
| *Planorbis antrosus* | .... | .... | .... | .... | .... | .... | 1 | .... | .... | 1 |
| *Planorbis campanulatus* | .... | .... | .... | .... | .... | .... | 2 | .... | .... | 2 |
| *Planorbis exacuous* | 6 | .... | .... | 1 | 2 | .... | .... | .... | .... | 9 |
| *Planorbis hirsutus* | 3 | .... | .... | .... | .... | 1 | .... | .... | .... | 4 |
| *Planorbis parvus* | 7 | .... | .... | 1 | .... | .... | 34 | 62 | .... | 104 |
| *Planorbis trivolvis* | 1 | .... | .... | .... | .... | .... | 2 | .... | .... | 3 |
| *Segmentina armigera* | .... | .... | .... | .... | .... | .... | 1 | .... | .... | 1 |
| *Physa warreniana* | .... | .... | .... | .... | .... | .... | 7 | .... | 1 | 8 |
| *Physa integra* | | | | | | | | 50 | | 50 |
| *Ancylus parallelus* | | | | | | | 2 | | | 2 |
| Total Mollusca | 211 | 2 | | 53 | 20 | 8 | 77 | 150 | 4 | 525 |
| Turbellaria | | | | | | | | | | |
| *Planaria maculata* | | | | | | 1 | | | | 1 |
| Hirudinea | | | | | | | | | | |
| *Glossiphonia stagnalis* | | | 1 | | | | | | | 1 |
| Oligochæta | | | | | | | | | | |
| *Dero limosa* | | | | | | | 1 | | | 1 |
| *Dero* species | | | | | | 1 | .... | .... | .... | 1 |
| *Stylaria* species | 12 | 3 | | | 2 | 4 | 9 | .... | .... | 30 |
| Naididæ | 13 | | | | | .... | 17 | .... | .... | 30 |
| Tubificidæ | 4 | .... | .... | .... | .... | 7 | 2 | .... | .... | 13 |
| Cladocera | | | | | | | | | | |
| *Acroperus harpæ* | .... | .... | .... | .... | .... | . | 7 | .... | .... | 7 |
| *Chydorus sphæricus* | .... | .... | .... | .... | .... | . | 2 | .... | .... | 2 |
| *Eurycercus lamellatus* | .... | .... | .... | .... | .... | .... | 7 | .... | .... | 7 |
| *Latona setifera* | .... | 1 | .... | .... | .... | .... | .... | .... | .... | 1 |
| *Simocephalus serrulatus* | | | | | | .... | 10 | .... | .... | 10 |
| *Simocephalus vetulus* | | | | | | | 1 | .... | .... | 1 |
| Ostracoda | | | | | | | | | | |
| Cypridiidæ | | | | | | | 13 | | | 13 |
| Amphipoda | | | | | | | | | | |
| *Gammarus fasciatus* | | | 1 | | | | | | | 1 |
| *Hyalella knickerbockeri* | | 2 | | 2 | 3 | | 83 | 41 | | 131 |
| Isopoda | | | | | | | | | | |
| *Asellus communis* | 2 | 2 | 7 | | 1 | 10 | 33 | 3 | | 58 |
| Odonata | | | | | | | | | | |
| *Enallagma* species, nymph | | | | | | | | 3 | | 3 |
| *Gomphus spicatus*, nymph | | 1 | | | | | | | | 1 |
| Trichoptera | | | | | | | | | | |
| *Agraylea multipunctata* | | | | | 3 | 2 | 26 | | | 31 |
| *Helicopysche borealis.* | | | | 3 | | | | | | 3 |
| *Molanna* species | | | | | | | 4 | | | 4 |
| *Oecetis incerta* | | | 1 | | | | | 2 | | 3 |
| *Platyphylax maculipennis* | | | 1 | | | | | | | 1 |
| Lepidoptera | | | | | | | | | | |
| *Nymphula* species, larva | | | | | | | | 1 | | 1 |
| Diptera | | | | | | | | | | |
| *Ablabesmyia* species | | | | x | | | | x | | x |
| *Chironomus* species | | 3 | 1 | x | | 3 | | x | | 7 |
| *Palpoymia*, larvæ-pupæ | | | | | | | 8 | x | | 8 |
| *Tanytarsus* species | | | | | 1 | | | | | 1 |
| Total of x | | | | 14 | | | | 57 | | 71 |
| Coleoptera | | | | | | | | | | |
| *Berosus* species | | | | | | | | 1 | | 1 |
| *Elmis bivittatus* | | | | 1 | | | | | | 1 |
| *Haliplus* species | | | | | | | 2 | | | 2 |
| Acarina | | | | | | | | | | |
| *Arrhenurus superior* | | | | | | | | 1 | | 1 |
| *Arrhenurus*, adult-immature | | | | | | | 8 | 5 | | 13 |
| *Limnesia* species | | | | | | | | 3 | | 3 |
| *Limnochares aquaticus* | | | | | | | | 1 | | 1 |
| *Piona* species | | 1 | | | | | | | | 1 |
| Total associated animals | 31 | 13 | 12 | 20 | 10 | 28 | 233 | 118 | 0 | 465 |
| Total animal life | | .... | .... | .... | .... | .... | .... | .... | | 990 |

NOTE.—Total of x signifies that the material examined contained several species which were not reported in the identification[8] hence the total is given for the entire number of species

*Planorbis parvus, Hyalella,* and *Asellus* are the characteristic animals of the mud bottom in shallow water (see figure 35).

2. *Mud Bottom, 6–12 Feet Deep.* Areas equivalent to 528 units (of 16 square inches*) were examined and 1,096 mollusks and 1,039 associated animals were collected, the average per unit area being 2.07 mollusks and 1.96 associated animals (Table No. 22, A). The large number of *Amnicola,* representing nearly 52 per cent of the total molluscan life, of which *Amnicola bakeriana* forms 34.9 per cent, is noteworthy. The 12 species of *Pisidium* total 15.2 per cent. Five species of clams were collected, of which *Elliptio complanatus* alone represented 73.4 per cent. Of the associated animals, dipterous larvæ compose 28 per cent and the ostracods 49.4 per cent. The latter, however, are small and their bulk is much less than that of the dipterous larvæ and other associated animals. The small number of Isopoda, Oligochæta, Amphipoda and Cladocera is noteworthy. Among the mollusks *Amnicola emarginata* and *Valvata sincera* may be noted as being confined to water 10 or more feet deep. *Lampsilis radiata oneidensis* first appears at a depth of 9 feet (see figures 36–38).

3. *Mud Bottom, 12–18 Feet Deep.* Two dredgings (96 small unit areas) were made in water deeper than 12 feet, in Lower South Bay. Mollusks afforded 181 individuals and associated animals 47; the averages for these are 1.88 mollusks and .48 associated animals, or 2.37 animals per unit area. Again *Amnicola* is the characteristic mollusk the two forms collected representing 18.7 per cent. *Amnicola bakeriana nimia* alone being 16.5 per cent. The five species of *Pisidium* total but 4 per cent. Three species of mussels were collected, of which *Elliptio complanatus* forms 89.4 per cent. The associated ani-

* The method of using the large dredge has been described on page 23. The area studied is approximately 768 square inches or the equivalent of 48 units (16 square inches). The 11 dredgings with the large dredge, therefore, total 528 of these smaller units. The number of animals is recalculated, by dividing the number of individuals of the dredge unit by 48, to facilitate comparison of the valuation with the smaller units of the other habitats. It should be borne in mind that there is not the accuracy in the deep water calculations that was possible in the shallow water.

FIG. 31. Invertebrate animals of a 16 square inch unit on clay bottom, Habitat No. lxxi, Field No. 918. Isopods (*Asellus*), the caddis-fly *Agraylea* (upper left hand corner), and the mollusk *Amnicola* are the principal animals present. *Hyalella* is abundant.

## Table No. 22. Number of Deep Water Animals, Mud Bottom

| Habitat numbers<br>Field numbers | cxlvi<br>1050 | cxlvii<br>1037 | cxlviii<br>1049 | cxlix<br>1048 | cl<br>1052 | cli<br>1035 | clii<br>1031 | cliii<br>1030 | cliv<br>1033 | clv<br>1032 | clvi<br>1034 | Total<br>A | clxi<br>1044 | clxii<br>1046 | Total<br>B | clvii<br>1037 | clviii<br>1038<br>1039 | clix<br>1040<br>1042 | clx<br>1043 | cxlv<br>801 | Total<br>C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth of water (in feet) | 8 | 10 | 16 | 8½ | 12 | 11½ | 9 | 8 | 10 | 11 | 11 | | 14 | 13 | | 15 | 15 | 18 | 14 | 10 | |
| Figures of animal life | | | 36 | 37 | | | | | | | 38 | | | | | 39 | 40 | 41 | | | |
| Algæ | | | | | | | | | | | | | | | | * | * | | | | |
| *Chara* species | x | | | | | | | | | | | | | | | | | | | x | |
| *Cladophora fracta* | | | | x | x | x | | | | | | | | | | | | | | x | |
| *Œdogonium* species | x | | | | | | x | | x | | | | | | | | | | | | |
| *Spirogyra* species | | | | | | | x | | | | | | | x | | x | x | x | | x | |
| *Tolypothrix* species | | | | | | | | | x | | | | | | | | | | | | |
| Mollusca | | | | | | | | | | | | | | | | | | | | | |
| *Anodonta cataracta* | 1 | | | | | | | | | | | 1 | | | | | | | | | |
| *Anodonta grandis footiana* | | | | | | 1 | | | | | | 1 | | | | | | | | | |
| *Lampsilis luteola* | | | 2 | | | | 4 | | 1 | | | 7 | 1 | 2 | 3 | | | 1 | | | 1 |
| *Lampsilis radiata oneidensis* | | | | | 2 | 7 | 4 | | | | | 13 | 6 | | 6 | | 2 | 2 | 2 | | 6 |
| *Elliptio complanatus* | 1 | | 2 | 5 | 9 | 20 | 9 | | 6 | | 9 | 61 | 65 | 11 | 76 | 11 | 26 | 41 | 20 | | 98 |
| *Sphærium striatinum* | | | | 2 | 8 | 2 | | | | | 2 | 14 | | 4 | 4 | 11 | | 15 | | | 26 |
| *Sphærium sulcatum* | | 1 | | 1 | 1 | | | | | | | 3 | | 5 | 5 | | | | | | |
| *Sphærium vermontanum* | | 3 | 1 | | | 7 | | | | | | 11 | 8 | | 8 | | | | 15 | | 15 |
| *Musculium* species | 2 | | | | | | | | | | | 2 | | | | | | | | | |
| *Pisidium abditum* | 2 | | | | | | | | | | | 2 | | | | | | | | | |
| *Pisidium complanatum* | | | | 1 | | | | | | | | 1 | | | | | | | | | |
| *Pisidium compressum* | | | 4 | 5 | 3 | | 3 | | | | 7 | 22 | 3 | | 3 | | | | | | |
| *Pisidium c. laevigatum* | | | | | | | | | | | | | | 2 | 2 | | | | | | |
| *Pisidium ferrugineum* | | | | 2 | | | | | | | | 2 | | | | | | | | | |
| *Pisidium neglectum* | | | | 3 | | | | | | | | 3 | | | | | | | | | |
| *Pisidium overi* | 1 | | | | | | | | | | | 1 | | | | | | | | | |
| *Pisidium pauperculum* | 3 | | | | | | | | | | | 3 | | | | | | | | | |
| *Pisidium scutellatum* | | 1 | | 3 | 2 | | 2 | | 2 | 1 | | 11 | | 2 | 2 | | | | 4 | | 4 |
| *Pisidium s. cristatum* | | | 4 | 74 | | | | | 1 | | | 79 | | 1 | 1 | | | | | | |
| *Pisidium variabile* | 10 | | 3 | 16 | | | | | 3 | | 8 | 40 | | 1 | 1 | | | | | | |
| *Pisidium vesiculare* | 2 | | | | | | | | | | 1 | 3 | | | | | | | | | |
| *Pisidium* species | | | | | | | | | | | | | | | | 1 | 1 | | | | 2 |
| *Vivipara contectoides* | | | | | | | 1 | | | | | 1 | | | | | | | | | |
| *Somatogyrus subglobosus* | | | | | | | | | | 1 | | 1 | | | | | | | 1 | | 1 |
| *Gillia altilis* | | | | | | | | | | | | | 1 | | 1 | | | | 5 | | 5 |
| *Bythinia tentaculata* | | | | | | | 3 | 8 | | | | 11 | 1 | | 1 | | | | 2 | 1 | 3 |
| *Amnicola bakeriana* | 24 | 2 | | 78 | 4 | | 210 | 1 | 4 | 15 | 5 | 343 | | | | 2 | | 1 | 12 | | 15 |
| *Amnicola emarginata* | | 2 | | | | 1 | | | | | 1 | 4 | | 5 | 5 | 4 | | 1 | | | 5 |
| *Amnicola limosa porata* | | | | | | | | | | | | | | | | | | 20 | | | 20 |
| *Amnicola oneida* | 10 | | | 45 | | 1 | 1 | | | 1 | | 58 | | | | | 1 | | | | 1 |
| *Amnicola bakeriana nimia* | 10 | 3 | 4 | 74 | 1 | 2 | 19 | | 4 | 6 | 5 | 128 | 34 | | 34 | 24 | 5 | | 20 | 83 | 132 |
| *Amnicola clarkei* | 13 | | | 27 | | | | | | | | 40 | | | | | | | | | |
| *Valvata sincera* | | | | | | 1 | | | | | | 1 | 13 | 6 | 19 | 14 | 1 | 14 | | | 30 |
| *Valvata tricarinata* | 8 | 3 | | 13 | 1 | | | | | 1 | | 26 | 4 | | 4 | 23 | | 21 | 4 | 1 | 49 |
| *Galba catascopium* | 2 | 2 | 1 | 16 | 3 | 2 | 29 | 1 | 1 | 6 | 4 | 67 | 2 | | 2 | | | | | 1 | 1 |
| *Planorbis antrosus* | | | | 1 | 1 | 1 | | | | 2 | | 5 | 1 | 2 | 3 | 1 | | 1 | 1 | | 3 |
| *Planorbis campanulatus* | | | | | | | 11 | 1 | | | | 12 | | | | | | | | | |
| *Planorbis exacuous* | 1 | | | | | | 3 | | 2 | | 2 | 8 | 1 | | 1 | 1 | | | 2 | | 3 |
| *Planorbis hirsutus* | | | | | | | 3 | | | | | 3 | | | | | | | | | |
| *Planorbis parvus* | | | | 3 | 1 | | 85 | | 2 | | | 91 | | | | | | | | | |
| *Physa warreniana* | | 1 | | 1 | | 2 | | | | | | 4 | | | | | | | | 4 | 4 |
| *Physa integra* | | | | | | | 3 | | 1 | | | 4 | | | | | | | | | |
| *Ancylus parallelus* | | | 1 | 1 | | | 4 | 1 | | | 2 | 9 | | | | | | | | | |
| Total Mollusca | 90 | 18 | 22 | 371 | 16 | 47 | 394 | 12 | 27 | 33 | 40 | 1006 | 140 | 41 | 181 | 92 | 36 | 117 | 88 | 90 | 423 |
| Porifera | | | | | | | | | | | | | | | | | | | | | |
| *Spongilla fragilis* | x | | | x | x | x | | | | | x | | | x | | | | | | x | |
| Turbellaria | | | | | | | | | | | | | | | | | | | | | |
| *Planaria maculata* | | 1 | | | | | | | | | | 1 | 1 | | 1 | | | | | | |
| Polyzoa | | | | | | | | | | | | | | | | | | | | | |
| *Plumatella punctata* | | x | x | | x | | x | x | | x | x | | x | | | | | | | x | |
| Hirudinea | | | | | | | | | | | | | | | | | | | | | |
| *Erpobdella punctata* | 3 | | | | | | | | | | | 3 | | | | | | | | | |
| *Glossiphonia complanata* | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| *Glossiphonia stagnalis* | 4 | | | | | | | | | | 1 | 5 | | | | | | | | | |
| Oligochæta | | | | | | | | | | | | | | | | | | | | | |
| *Stylaria* species | | 2 | | | | | | | | | | 2 | | | | | | | | | |
| Naididæ | | 20 | | | | | | 1 | | | | 21 | | | | | | | | | |
| Tubificidæ | 8 | | 3 | | | | | | | | | 11 | | 2 | 2 | | | | | | |
| Cladocera | | | | | | | | | | | | | | | | | | | | | |
| *Sida crystallina* | | | | | | | 2 | | | | | 2 | | | | | | | | | |
| *Simocephalus serrulata* | | | | | | | 3 | | | | | 3 | | | | | | | | | |
| Ostracoda | | | | | | | | | | | | | | | | | | | | | |
| Cypridæ | | | | 502 | | | 10 | | | 2 | | 514 | | | | | | | | | |
| Amphipoda | | | | | | | | | | | | | | | | | | | | | |
| *Gammarus fasciatus* | | | 1 | | | | | | | | | 1 | | | | | | | | | |
| *Gammarus limnaeus* | | | | | | | 2 | | | | | 2 | | | | | | | | | |
| *Hyalella knickerbockeri* | | 5 | | | | | 17 | | 2 | | | 24 | 1 | | 1 | | 2 | | | 12 | 14 |
| Isopoda | | | | | | | | | | | | | | | | | | | | | |
| *Asellus communis* | 16 | | 1 | | | | | | | | | 17 | | | | | | | | | |
| Ephemerida | | | | | | | | | | | | | | | | | | | | | |
| *Ephemerella* species, nymph | | | | 1 | | | | | 2 | | | 3 | 2 | | 2 | | 2 | | 2 | | 4 |
| *Hexagenia* species, nymph | | | 9 | 3 | 2 | 2 | | | 1 | | | 17 | | 7 | 7 | 1 | 3 | | | | 4 |
| Neuroptera | | | | | | | | | | | | | | | | | | | | | |
| *Sialis infumata*, larva | | | | 1 | | | | | | | | 1 | | | | | | | | | |
| Odonata | | | | | | | | | | | | | | | | | | | | | |
| *Didymops transversa*, nymph | | | | 1 | | | | | | | | 1 | | | | | | | | | |
| *Tetragoneuria cynosura* nymph | | | | | | | | | | | 1 | 1 | | | | | | | | | |
| Hemiptera | | | | | | | | | | | | | | | | | | | | | |
| *Notonecta* species, adult | | | | | | | | | | | | | | | | | 10 | | 4 | | 14 |
| *Notonecta* species, nymph | | | | | | | | | | | | | | | | | 4 | | | | 4 |
| Trichoptera | | | | | | | | | | | | | | | | | | | | | |
| *Agraylea multipunctata* | | | | 4 | 1 | | 49 | | | 2 | 8 | 64 | | | | | | | | | |
| *Hydroptila* species | | | | | | | | | | | | | | | | | | | | 3 | 3 |
| Leptocerid larvæ | 1 | 1 | | 4 | | 6 | | | 1 | | | 13 | 16 | 1 | 17 | | | | | 1 | 1 |
| Limnephilid larvæ | | | | 1 | | | 1 | | | | | 2 | | | | | 2 | | | | 2 |
| *Molanna* species | | 6 | 1 | 11 | | 7 | | | | | | 25 | 5 | 8 | 13 | | | 3 | | | 3 |
| *Œcetis inceria* | | 2 | | 2 | | | 4 | 1 | | | | 9 | | | | | | 2 | | | 3 |
| *Platyphylax maculipennis* | | | | | | | | | | | | | 1 | | 1 | | | | 2 | | 2 |
| Lepidoptera | | | | | | | | | | | | | | | | | | | | | |
| *Nymphula* species, larva | | | | | | | 1 | | | | | 1 | | | | | | | | | |
| Diptera | | | | | | | | | | | | | | | | | | | | | |
| *Ablabesmyia* species | 5 | | | | | | | | | 1 | | 6 | | | | | | | | 1 | 1 |
| *Chironomus* species | 17 | 23 | x | 29 | 7 | 6 | x | 20 | 15 | 5 | x | 122 | 3 | | 3 | 2 | 11 | | 7 | | 20 |
| *Procladius* species | 1 | | | | | | | | | | | 1 | | | | | | | | | |
| *Palpomyia* species | | 1 | | | | | 2 | | | | 1 | 4 | | | | | 1 | | | | 1 |
| Tanypinæ | | | x | | | | | | | | | x | | | | | | | | | |
| *Tanytarsus* species | 14 | | | | | | x | | | | x | 14 | | | | | | 1 | | | 1 |
| Total of x | | | 44 | | | | 32 | | | | 67 | 143 | | | | | | | | | |
| Coleoptera | | | | | | | | | | | | | | | | | | | | | |
| *Gyrinus* species, larvæ | | 1 | | | | | | | | | 1 | 2 | | | | | | | | | |
| Acarina | | | | | | | | | | | | | | | | | | | | | |
| *Arrhenurus* nymph | 1 | | | | | | | | | | | 1 | | | | | | | 1 | | 1 |
| *Hygrobates* species | | | | | | | 1 | | | | | 1 | | | | | | | | | |
| *Limnesia* species | | | | | | | | | | | | | | | | | | | | | |
| *Piona* species | | | | | | | | | | | 1 | 1 | | | | | 1 | | | | 1 |
| *Unionicola* species | | | | | | | 1 | | | | | 1 | | | | | | | | | |
| Total associated animals | 70 | 62 | 59 | 559 | 10 | 21 | 125 | 22 | 21 | 10 | 80 | 1039 | 29 | 18 | 47 | 3 | 36 | 6 | 17 | 17 | 79 |
| Total animal life | | | | | | | | | | | | 2135 | | | 228 | | | | | | 502 |

* With some gravel.

Note — Total of x signifies that the material examined contained several species which were not separated in the identification, hence the total is given for the entire number of species mals are few in number, the Trichoptera being the most numerous. Oligochæta, Amphipoda, Isopoda, and dipterous larvæ, so abundant in shallow water, are here wanting or but few in number (Table No. 22, B).

A comparison of the three areas just described shows that there is a marked decrease in the number of individuals and an increase in the numerical ratio of mollusks to the associated animals. The decrease in number of individuals is graphically shown in the following table indicating the number of animals per unit area (16 square inches):

Table No. 23

| Depth of water | Associated animals | Mollusks | Total |
|---|---|---|---|
| 1– 6 feet | 17.22 | 19.44 | 36.66 |
| 6–12 feet | 1.96 | 2.07 | 4.04 |
| 12–18 feet | .48 | 1.88 | 2.37 |

The mollusks are seen to decrease markedly in number in the area between 6 and 12 feet in depth, being but 11 per cent of the inhabitants of the same area in shallow water. In the deeper water (12–18 feet) the percentage is but 6.5. The number of species does not show such a striking decrease as do the individuals, shallow water (1–6 feet) having 22 species, deeper water (6–12 feet), 38 species, and deepest water (12–18 feet), 21 species. The median depth thus has the greatest number of species.

Deeper water beyond the area of Lower South Bay shows a farther decrease in animal life, six dredgings (equivalent to 288 small unit areas) totaling 423 mollusks and 79 associated animals or an average of 1.46 mollusks and .27 associated animals (Table No. 22, C). *Amnicola* and *Valvata* are the dominant species, the former (five species) totaling 40.8 per cent and the latter (two species), 18.4 per cent. One species of *Amnicola* (*bakeriana nimia*) alone provides 31.2 per cent of this amount. *Amnicola* and *Valvata* represent 59.3 per cent of the total molluscan life. *Elliptio complanatus* is the most abundant mussel, representing 93.3 per cent of this class of mollusks (see figures 39–41). The absence of *Physa* and the

FIG. 32. Invertebate animals of a 16 square inch unit on clay bottom, Habitat No. lxxv, Field No. 923. *Asellus* and *Hyalella,* both crustaceans, are the principal animals.

small number of *Galba* and *Planorbis* is especially notable. *Pisidia* decrease to two species and but a small fraction of a per cent of the total number of individuals. The small number of associated animals is also a feature influenced by depth, chironomid larvæ and *Hyalella* forming 58.2 per cent of the associated animals.

The increase with depth of the relative numbers of mollusks over associated animals is striking, and is shown below:

| Depth in feet | Mollusks | Associated animals |
|---|---|---|
| 6–12 .......................... | 51.33 per cent | 48.67 per cent |
| 13–14 .......................... | 79.39 per cent | 20.61 per cent |
| 14–18 .......................... | 84.26 per cent | 15.74 per cent |

The number of species and the quantity of algæ decrease with depth, *Spirogyra* being the only species noted in water deeper than 12 feet. This is probably one of the causes of the decrease in animal life at this depth.

4. *Quantitative Data for Mud Bottom.* The average population of the mud bottoms is shown in Table No. 38. On the basis of these averages the total animal population of the mud areas is calculated to be:*

| No. of units | Depth | Mollusks | Associated animals | Total | Acres | Average per acre |
|---|---|---|---|---|---|---|
| 27 | 1– 6 feet | 114,342,386 | 101,275,693 | 215,618,079 | 15 | 14,374,538 |
| 11 | 6–12 feet | 305,203,140 | 289,178,505 | 594,381,645 | 375 | 1,585,018 |
| 2 | 12–15 feet | 217,264,530 | 56,361,992 | 273,626,522 | 294 | 930,359 |
| | Total..... | 636,810,056 | 446,816,190 | 1,083,626,246 | | |

* The computations for these are as follows:

1–6 feet; 6,272,640 square inches in one acre × 15 acres = 94,089,600 square inches in 15 acres ÷ 16 (sq. in. unit) = 5,880,600 unit areas, × 19.44 mollusks = 114,342,386 mollusks, and × 17.22 associated animals = 101,275,693 associated animals, + 114,342,286 mollusks = 215,618,079, total calculated animal population.

6–12 feet; 6,272,640 × 375 = 2,352,240,000 square inches ÷ 16 = 147,015,000 unit areas, × 2.076 = 305,203,140 mollusks, and × 1.967 = 289,178,505 associated animals + 305,203,140 = 594,381,645, total animal population.

12–14 feet; 6,272,640 × 294 = 1,844,155,160 square inches in 294 acres ÷ 16 = 115,259,697 unit areas, × 1.885 = 217,264,530 mollusks, and × .489 = 56,361,992 associated animals + 217,264,530 = 273,626,522, total animal population.

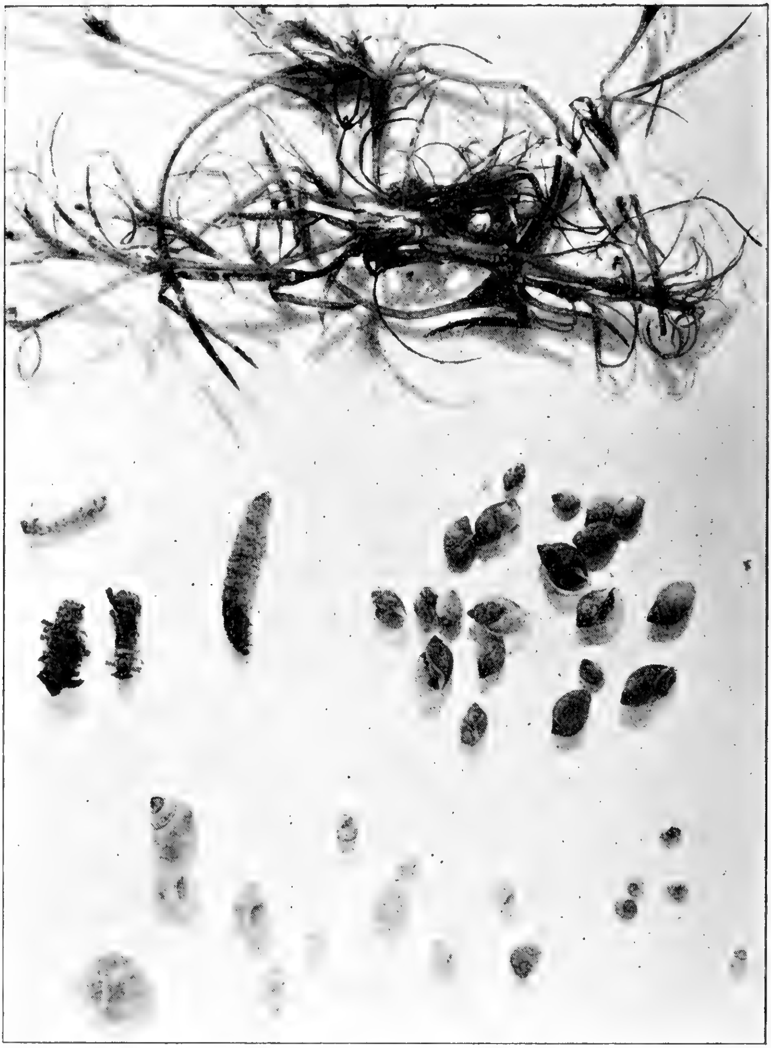

FIG. 33. Invertebrate animals of a 16 square inch unit on clay bottom, Habitat No. cx, Field No. 997. The mollusk *Physa* is the principal animal present. The plant is *Naias flexilis*, which is common in this habitat.

The decrease in number of individuals below the 6-foot contour is marked and shows that the shallow water area is the most valuable for producing fish food.

**Mussel Population.** The apparatus used for collecting the 16 square inch units is too small to obtain a fair sample of the adult mussels. For the purpose of ascertaining the relative abundance of the mussel fauna a tin frame was made, 8 inches square, which covered an area of 64 square inches (about 400 square cm.). This was fastened to a line and with this apparatus (fig. 2) the number of mussels per unit area could be easily ascertained when the water was quiet and the depth not greater than six feet. In some habitats in shallow water the mussels were so widely separated that they could be estimated only per square yard. For the sake of uniformity all 64 square inch units are increased to square yards. The three tables which follow (Nos. 24, 25, 26) indicate the number of mussels per unit area in the habitats examined.*

TABLE NO. 24. MUSSELS ON BOULDER AND GRAVEL BOTTOMS

| Habitat numbers | vii | viii | x | xvi | xxii | xli | xlvii | Total |
|---|---|---|---|---|---|---|---|---|
| Depth in feet | 3 | 3 | 1½ | 1½ | 2¼ | 2¾ | 6 | ..... |
| Number of units | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 14 |
| *Anodonta cataracta* | 4 | ... | 2 | ... | ... | ... | ... | 6 |
| *Anodonta implicata* | 11 | ... | ... | ... | ... | ... | ... | 11 |
| *Anodonta grandis footiana* | ... | ... | ... | 2 | ... | ... | ... | 2 |
| *Elliptio complanatus* | 12 | 12 | ... | 12 | 1 | 1 | 1 | 39 |
| *Lampsilis luteola* | ... | 4 | ... | ... | ... | ... | ... | 4 |
| *Lampsilis radiata* | 13 | 4 | ... | 6 | 1 | ... | ... | 24 |
| Total | 40 | 20 | 2 | 20 | 2 | 1 | 1 | 86 |

* Computations for mussel population.

Boulder and gravel; 43,560 sq. ft. ÷ 9 feet = 4,840 unit areas of one square yard in one acre, × 20 acres = 96,800 unit areas in 20 acres, × 6.14 mussels = 594,545 mussels in 20 acres.

Sand; 4,840 unit areas × 85 acres = 411,400 unit areas in 85 acres, × 6.39 mussels = 2,630,080 mussels in 85 acres.

Clay; 4,840 × 92 = 445,280 unit areas in 92 acres, × 13 = 5,788,640 mussels in 92 acres.

FIG. 34. Invertebrate animals of a 16 square inch unit on sandy clay bottom, Habitat No. xciii, Field No. 957. *Hyalella,* chironomid larvæ, and *Planorbis* are the principal animals present.

TABLE NO. 25. MUSSELS ON SAND BOTTOM

| Habitat numbers | xiii | xvii | xviii | xix | xxvii | xxxiv | xxxv | lxv | xcviii | xcix | ci | cxxv | cxxvi | cxxvii | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth in feet | 1½ | 3 | 3 | 2½ | 3 | 1½ | 4 | 3 | 4 | 3 | 3 | 4½ | 3 | 4½ | .... |
| Number of units | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 28 |
| *Anodonta grandis footiana* | 2 | .... | .... | 1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 3 |
| *Lampsilis luteola* | .... | .... | .... | .... | .... | .... | .... | .... | 7 | 9 | 10 | .... | 3 | 3 | 32 |
| *Lampsilis radiata* | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 3 | 3 | 6 |
| *Elliptio complanatus* | 2 | 1 | 20 | .... | 1 | 2 | 1 | 10 | 23 | 19 | 30 | 1 | 14 | 14 | 138 |
| Total | 4 | 1 | 20 | 1 | 1 | 2 | 1 | 10 | 30 | 28 | 40 | 1 | 20 | 20 | 179 |

FIG. 35. Invertebrate animals of a 16 square inch unit on mud bottom, Habitat No. xxxvi, Field No. 834, water 1½ feet deep. The amphipod *Hyalella* predominates, followed by *Planorbis parvus*. *Agraylea multipunctata* and *Asellus*.

TABLE NO. 26. MUSSELS ON CLAY AND SANDY CLAY BOTTOMS

| Habitat numbers | lx | lxiii | lxxi | liv | lxxxvi | lxxxviii | xc | Total |
|---|---|---|---|---|---|---|---|---|
| Depth in feet | 5½ | 1½ | 4 | 3 | 3 | 3 | 3½ | ..... |
| Number of units | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 14 |
| *Anodonta cataracta* | 7 | 5 | ... | 2 | .... | ..... | .. | 14 |
| *Anodonta grandis footiana* | 2 | ... | ... | 6 | .... | ..... | .. | 8 |
| *Lampsilis luteola* | 3 | 3 | ... | 4 | 15 | 19 | .. | 44 |
| *Elliptio complanatus* | 8 | 12 | 20 | 8 | 30 | 37 | 1 | 116 |
| Total | 20 | 20 | 20 | 20 | 45 | 56 | 1 | 182 |

The mussel populations of these areas are, therefore, boulder and gravel, 594,545; sand, 2,630,080; and clay, 5,788,640; or a total estimated population of 9,013,265 mussels in 197 acres of Lower South Bay. Some features shown by the average population are interesting. The greatest number of individuals occurred on a clay or sandy clay bottom. Twice as many mussels occurred in water deeper than six feet than within the 6-foot contour. These features are expressed in the Table No. 27, the figures being averages per unit area of nine square feet.

TABLE NO. 27. AVERAGE NUMBER OF MUSSELS ON BOTTOM

| | |
|---|---|
| Boulder and gravel bottom | 6.14 |
| Sand bottom | 6.39 |
| Clay and sandy clay bottom | 13.00 |
| Mud bottom | 10.26 |
| Within 6-foot contour | 7.84 |
| Outside 6-foot contour | 16.85 |

The above table shows that mussels are more abundant on the mud bottom in deep water (8–14 feet) than on sand, gravel, boulder, or clay in shallow water (1–6 feet). These are the only studies of this character known to me.

**Population of the Vegetation.** The higher plants of Lower South Bay and vicinity were examined to ascertain the amount of animal life using vegetation for food and support.


FIG. 36. Invertebrate animals from approximately 768 square inches on mud bottom, Habitat No. cxlviii, Field No. 1049, water 10 feet deep. Chironomid larvæ and *Hexagenia* nymphs are the principal live animals. The large number of caddis-fly cases (mostly *Molanna* and leptocerids, all empty and not used in the valuation tables) and the small number of mollusks is noteworthy. The mussels collected are not figured.

TABLE 28. QUANTITATIVE VALUES OF VEGETATION UNITS

| Habitat numbers | iii | lxxxvii | lxxxviii | xcii | xciii | xciii | xciii | xciv | xcv | xcv | xcvi | xcvi | cv | cix | cx | cxix | cxxiv | cxxvi | cxxviii | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distance from shore in feet | 10 | 25 | 100 | 300 | 200 | 200 | 200 | 300 | 250 | 250 | 100 | 100 | 400 | 100 | 10 | 100 | 30 | 25 | 200 | ...... |
| Depth in feet | 2 | 1½ | 3 | 5 | 3½ | 3½ | 3½ | 5 | 4 | 4 | 4 | 4 | 6 | 1½ | 4 | 2 | 2 | 3 | 5½ | ...... |
| Bottom material* | s | sc | sc | sc | sc | sc | sc | sc | sc | sc | sc | sc | sc | gb | c | s | s | s | s | ...... |
| *Potamogeton interruptus* | | | | | | | 1 | | | | | 1 | | | 1 | 9 | 3 | | 1 | 16 |
| *Potamogeton richardsonii* | | | | 1 | | 1 | | | | | | | 2 | | 5 | 8 | 5 | 11 | 4 | 37 |
| *Potamogeton robbinsii* | | 15 | 1 | | | | | 2 | | | 1 | 1 | | | | | | | | 20 |
| *Potamogeton perfoliatus* | | | | 3 | 2 | 2 | 3 | | | | 2 | | 3 | | | | | | | 15 |
| *Potamogeton zosterifolius* | | | | | | | | | 3 | | | 3 | 4 | | 7 | | | | | 17 |
| *Potamogeton natans* | | | 1 | | 1 | | | | 1 | | | 1 | | | | | | | | 4 |
| *Dianthera americana* | 8 | | | | | | 1 | | 2 | 1 | | | | | | | | | | 12 |
| *Myriophyllum verticillatum* | | 4 | 1 | 10 | | | 3 | 5 | | 1 | 4 | | | | 1 | | | | | 29 |
| *Elodea canadensis* | | 5 | | | | | | | | | | | | | 1 | | | | | 6 |
| *Najas flexilis* | | | | | | | | | | | | | | 53 | 12 | | | | | 65 |
| *Vallisneria spiralis* | | | | | | | 1 | 2 | | | | 2 | | | | | | | 3 | 8 |
| *Scirpus occidentalis* | | | | | | 2 | | | | | | | | | | | | | | 2 |
| *Scirpus americanus* | | 1 | | | | | 1 | | | | | | | | | | | | | 2 |
| *Scirpus smithii* | | 1 | | | | | | | | | | | | | | | | | | 1 |
| Total | 8 | 26 | 3 | 14 | 3 | 5 | 10 | 9 | 6 | 2 | 7 | 8 | 9 | 53 | 27 | 17 | 8 | 11 | 8 | 234 |

* Bottom symbols: c, clay; sc, sandy clay; s, sand; b, boulder; g, gravel. Duplicated habitat numbers indicate several samples taken in these habitats.

FIG. 37. Invertebrate animals from 768 square inches on mud bottom, Habitat No. cxlix, Field No. 1048, water 8½ feet deep. Mollusks are here the principal animals. *Pisidium* and *Amnicola* predominating. Chironomid larvæ and trichopterid larvæ are also numerous. The odonate nymph is *Didymops*. Caddis-fly cases are empty. Compare with figure 36. Mussels not figured.

Before discussing the animal inhabitants of the plants it may be well to ascertain the quantity of vegetable life in the area. Animal life is dependent, in the ultimate analysis, upon plant life for food and an abundant flora is in general necessary before an abundant fauna is possible.

Twenty unit areas, each 8 inches square (64 square inches, determined by means of the tin frame used for measuring the mussel distribution) were examined, the plants ranging from two to 53 per unit. The data obtained is shown in Table No. 28. Fourteen species of plants are included, the total number of individuals in the 20 units being 234, or an average of 11.7 plants per unit area. There are 25,550,444 square feet within the 12-foot contour (measured with the planimeter) and if the average given above holds good for the entire territory, there are upwards of 672,615,438 plants in this portion of Lower South Bay,* bordering the shore.

The result of the examination of the plants was somewhat unexpected, animal life being comparatively scarce. This may have been due to the great amount of filamentous algæ covering the bottom which provides a better forage ground than the higher plants. The vegetation may be divided into two types, floating and submerged (also called emergent and submerged).

1. *Floating Plants* (emergent). These include the water-lily leaves (*Nymphæa* and *Castalia*), the floating pond-weed (*Potamogeton natans*), and the filamentous alga (*Œdogonium*), which was floating on the surface of the water in one habitat. On the *Potamogeton natans,* in Habitat No. xv, a single adult individual of *Planorbis antrosus* was observed. No animal of any kind other than the *Planorbis* was noted on this plant. In Habitat No. cx, in a lagoon east of the steamboat landing in Lower South Bay, the surface of the water over an area estimated to be 150 by 50 feet (7,500 square feet) was covered with the filamentous alga, *Œdogonium.* A unit area contained the following life:

* The computation for this is as follows: 25,550,444 square feet × 144 square inches = 3,679,263,936 square inches ÷ 64 square inches = 57,488,499 unit areas, × 11.7 plants per unit area = 672,615,438 plants.


FIG. 38. Invertebrate animals from 768 square inches on mud bottom, Habitat No. clvi, Field No. 1034, water 11 feet deep. Chironomid larvæ predominate. *Amnicola* has the greatest number of individuals among the mollusks. Many of the molluscan shells (as well as all the caddis-fly cases) are without the animals and they are not counted in the valuation tables. The mussels collected are not figured.

| | | | |
|---|---|---|---|
| Mollusks. | *Pseudosuccinea c. chalybea*.... | 6 | (9–11 mm.) |
| | *Galba humilis modicella*...... | 2 | (5 mm.) |
| | *Physa warreniana* ........... | 1 | (10 mm.) |
| | *Planorbis campanulatus* ...... | 1 | (adult) |
| | *Bythinia tentaculata* ......... | 1 | (adult) |
| | | —— | 11 mollusks. |
| Oligochæta. | Naididæ .................... | 5 | |
| Amphipoda. | *Hyalella knickerbockeri* ...... | 1 | |
| Diptera. | Chironomid *pupa* ............ | 1 | |
| | | —— | 7 associated animals. |
| | Total....................... | 18 | |

The area of 7,500 square feet contains 16,875 unit areas (64 square inches), which provide a total calculated population of 185,625 mollusks and 118,125 associated animals, or a total population of 303,750.

By far the greatest area of floating plants is made up of the leaves of the two water-lilies, *Nymphæa advena* and *Castalia*

Table No. 29. Population of Water-lily Leaves

| Habitat numbers | xxviii | l | lxxxvi | Total |
|---|---|---|---|---|
| Depth of water in feet | $3\frac{1}{2}$ | $2\frac{3}{4}$ | 3 | ...... |
| Average size of leaf (inches) | 10 | $8\frac{3}{4}$ | $8\frac{1}{4}$ | 9 |
| Number of leaves examined | 17 | 3 | 12 | 32 |
| Mollusks | | | | |
| *Pseudosuccinea c. chalybea* | 11 | ..... | ..... | 11 |
| *Planorbis parvus* | 1 | ..... | 2 | 3 |
| *Physa warreniana* | 5 | 2 | 6 | 13 |
| *Ancylus parallelus* | ..... | 9 | 6 | 15 |
| Total | 17 | 11 | 14 | 42 |
| Associated animals | | | | |
| Amphipoda | | | | |
| *Hyalella knickerbockeri* | ..... | 1 | ..... | 1 |
| Coleoptera | | | | |
| *Donacia cincticornis* | ..... | ..... | 1 | 1 |
| *Galerucella nymphææ* (larva) | ..... | ..... | 1 | 1 |
| *Gyrinus*, eggs | ..... | ..... | x | x |
| Diptera. | | | | |
| *Chironomid* larvæ | ..... | 2 | ..... | 2 |
| *Palpomyia* larvæ | ..... | ..... | 2 | 2 |
| Ceratopogoninæ larvæ | ..... | ..... | 4 | 4 |
| Total number of animals | 0 | 3 | 8 | 11 |


FIG. 39. Invertebrate animals from 768 square inches on mud bottom, Habitat No. clvii, Field No. 1037, water 15 feet deep. The great predominance of mollusks (140 specimens) over associated animals (3) is to be noted. *Amnicola* and *Valvata* are the principal genera present. The caddis-fly cases are all empty.

*odorata*. Leaves were examined in three habitats the result of which is shown in the Table No. 29. The actual area covered by water-lily leaves has been difficult to determine with any degree of accuracy. The most satisfactory method has been to estimate the number and size of isolated patches of water covered with leaves and from this result try to arrive at a conclusion regarding the amount of life present. These areas are noted on the map showing distribution of plants (figures 18–20). A careful computation shows that the water-lily areas cover about 855,000 square feet. The leaves are scattered so as to average one leaf in two square feet, and there is therefore a total of approximately 427,500 lily leaves. Animal life was noted on three out of five leaves, and the inhabited leaves thus number 256,500 and the total amount of animal life is computed to be 424,507 individuals, of which 336,528 are mollusks and 87,979 are associated animals.*

In Habitat No. lvi, the surface of the water in a group of *Typha angustifolia*, embracing an area of 400 square feet, was covered with dead leaves of this Cat-tail, upon which considerable animal life found food and support. A single unit (64 square inches) was examined giving the result shown in Table No. 30. The water was from one to three feet deep. If the number of animals found in the unit area is indicative of the whole area, there are 2,700 mollusks and 3,600 associated animals, or a total population of 6,300.

In Habitat No. lxxxvii, an area of Bur-reed (*Sparganium eurycarpum*) of about 300 square feet borders the shore in water 16 to 18 inches deep. Nine *Ancylus parallelus* were collected on this plant in a single unit (64 square inches). On this basis there are 6,075 individuals of this mollusk on the leaves of Bur-reed in this vicinity.‡

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* Computation: 42 and 11 ÷ 32 = 1.31 mollusks and .34 associated animals per leaf, × 256,500 lily leaves = 336,528 mollusks and 87,979 associated animals.

† Computation: 400 square feet × 144 square inches = 57,600 square inches ÷ 64 square inches = 900 unit areas × 3 = 2,700 mollusks and × 4 = 3,600 associated animals.

‡ Computation: 300 square feet × 144 square inches = 43,200 square inches ÷ 64 square inches = 675 unit areas × 9 = 6,075 mollusks.

FIG. 40. Mussels from 768 square inches on mud bottom, Habitat No clviii, Field No. 1039, water 15 feet deep. The mussel *Elliptio complanatus* is represented by 26 specimens, and *Lampsilis radiata oneidensis* by 2 specimens.

2. *Submerged Plants.* The submerged vegetation on the whole contained but few animals. In spots, however, mostly in sheltered places, animals were quite abundant. In Habitat No. cxv, a quiet lagoon with mud bottom, the water, which was four feet deep, was almost choked with vegetation (see the vegetation map, fig. 19). Among the plants, *Potamogeton interruptus* and *Myriophyllum verticillatum* had an abundance of animals on the leaves. The population of a 64 square inch unit is shown in Table No. 31.

TABLE NO. 30. POPULATION OF TYPHA UNIT

| | |
|---|---|
| Mollusks | |
| *Planorbis binneyi*, young | 1 |
| *Ancylus parallelus* | 2 |
| | 3 |
| Associated animals | |
| Hirudinea | |
| *Glossiphonia stagnalis* | 1 |
| *Erpobdella punctata* | 1 |
| | 4 |
| Amphipoda | |
| *Hyalella knickerbockeri* | 1 |
| Diptera | |
| Chironomid larva | 1 |

TABLE NO. 31. POPULATION OF VEGETATION, HABITAT NO. CXV

| | | |
|---|---|---|
| *Potamogeton interruptus* | × | .... |
| *Myriophyllum verticillatum* | .. | × |
| *Acella haldemani* | .. | 2 |
| *Planorbis parvus* | 22 | .... |
| *Physa integra* | 10 | 30 |
| Total | 32 | 32 |

In this lagoon there is an area of 60,000 square feet, the water being four to six feet deep, and the total animal population is calculated to be not less than 8,640,000 individuals.* The

* Computation: 60,000 square feet × 144 square inches = 8,640,000 square inches ÷ 64 square inches = 135,000 unit areas × 64 mollusks = 8,640,000 mollusks.

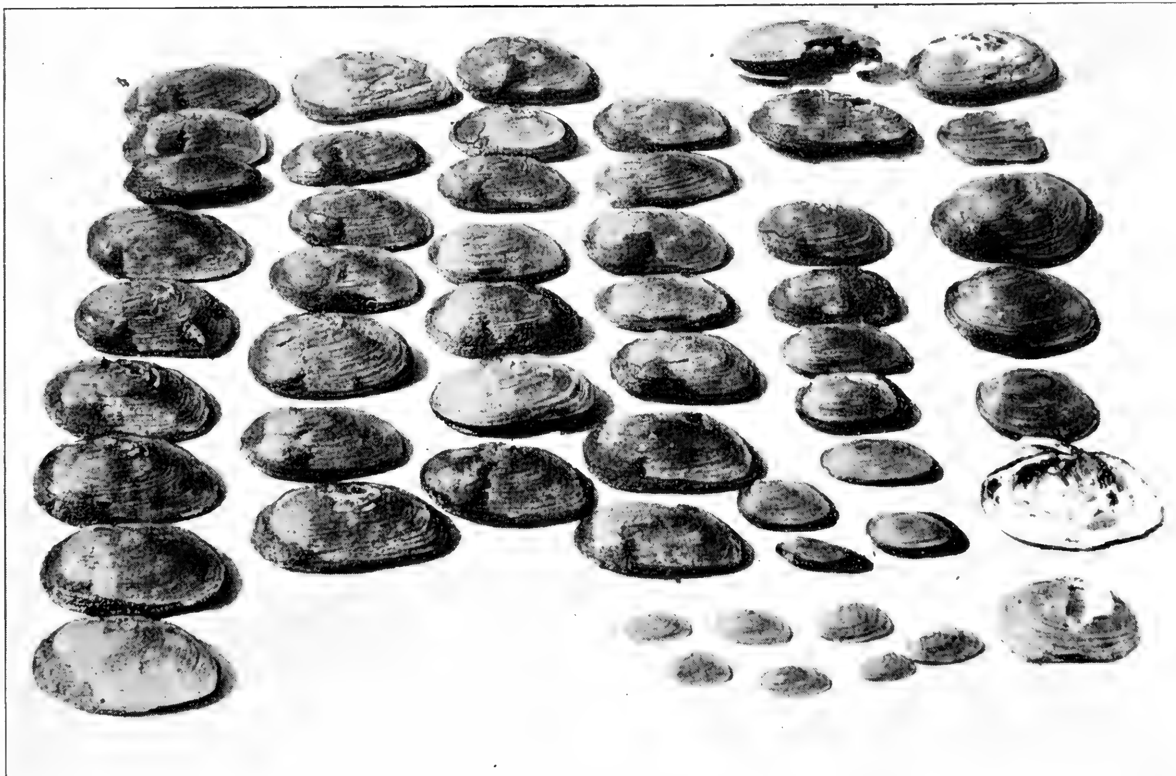

FIG. 41. Mussels from 768 square inches on mud bottom. Habitat No. clix, Field No. 1040, water 18 feet deep. Three species are represented, 1 specimen of *Lampsilis luteola*, 28 of *Lampsilis radiata oneidensis*, and 47 of *Elliptio complanatus*. A few shells of the latter are without the animal.

absence of associated animals is noteworthy. An area of about 5,000 square feet north of the club house on Norcross Point (Habitat No. cxxiv) contains several species of *Potamogeton*. The water is two feet deep and the bottom of hard sand. Life from a 64 square inch unit is shown in Table No. 32. On the basis of this average there are 247,500 mollusks and 90,000 associated animals, or a total animal population of 337,500 individuals.*

TABLE No. 32. POPULATION OF VEGETATION, HABITAT No. CXXIV

| | | |
|---|---|---|
| Mollusks | | |
| *Physa integra* | 6 | |
| *Planorbis parvus* | 12 | |
| *Bythinia tentaculata* | 4 | |
| | 22 | specimens |
| Associated animals | | |
| Amphipoda | | |
| *Hyalella knickerbockeri* | 4 | |
| Trichoptera | | |
| Caddis-fly larvæ | 3 | |
| Acarina | | |
| Water mite | 1 | |
| | 8 | specimens |

In Habitat No. cxxviii, off Norcross Point, in 5½ feet of water, sand bottom, a large area of *Vallisneria spiralis* occurs. Leaves from a unit area (64 square inches) were examined and contained the animal life shown in Table No. 33. The extent of the territory covered by this plant was not ascertained. It was studied over an area fully 50 by 100 feet (5,000 square feet), and in this place there must be on this basis 45,000 mollusks and 56,250 associated animals, a total calculated population of 101,250.†

* Computation: 5,000 square feet × 144 square inches = 720,000 square inches ÷ 64 square inches = 11,250 unit areas × 22 mollusks = 247,500 mollusks and × 8 associated animals = 90,000 associated animals, a total animal population of 337,500, individuals.

† Computation: 5,000 square feet × 144 square inches = 720,000 square inches ÷ 64 square inches = 11,250 unit areas × 4 mollusks = 45,000 mollusks, and × 5 associated animals = 56,250 associated animals, a total calculated population of 101,250.

FIG. 42. Invertebrate animals from 100 square feet on a log covered with filamentous algæ (*Cladophora fracta, Œdogonium* species), Habitat No. iv, Field No. 708, water 5 feet deep. The principal species are *Bythinia tentaculata, Amnicola bakeriana nimia* and *Hyalella knickerbockeri.*

TABLE No. 33. POPULATION OF VEGETATION, HABITAT No. CXXVI

| | | |
|---|---|---|
| Mollusks | | |
| *Ancylus parallelus* | 4 | specimens |
| Associated animals | | |
| Hirudinea | | |
| *Glossiphonia fusca* | 2 | |
| Trichoptera | | |
| Caddis-fly larva | 1 | |
| Diptera | | |
| Chironomid larvæ | 2 | |
| | 5 | specimens |

The total animal population of the submerged and floating vegetation as calculated for the 1916 survey, aggregates 9,463,428 mollusks and 355,954 associated animals, a total population of 9,819,382. It is probable that a far greater animal population occupies the area covered by the vegetation than is here indicated. The unit areas are too few (a total of 10) in number to include the entire area as was done with the bottom fauna, the units of which were much more numerous. As stated on a previous page, the results of the survey of vegetation were somewhat unexpected, the amount of life falling short of that recorded for the animal life among the plants of the outlet at Brewerton in the fall of 1915. It is possible that the extensive use of the vegetation in the outlet may be due to the lateness of the season or perhaps to the difference of location. A study of this phase of the subject in Lower South Bay at different seasons would help to solve the problem.

In connection with the use of the higher plants as food by invertebrate animals, the results of investigations on *Potomatogen* by Moore ('15, p. 284) are of interest. Sixteen species of animals were found on 9 species of plants and the majority of animals were observed to eat the tissue of the plants. The groups observed were as follows:

Lepidoptera
- *Nymphula*

Trichoptera
- Leptoceridæ (two species)
- Hydroptilidæ
- Undetermined species

Diptera
- *Chironomus*
- *Cricotopus trifasciatus*
- *Cricopteris*
- *Hydrellia*
- *Tanytarsus*
- *Tanytarsus flavellus*

Coleoptera
- *Donacia*

Oligochaeta
- *Nais* (very abundant)

Crustacea (very abundant)
- *Eucrangonyx*
- *Gammarus*
- *Hyalella*

Mollusca
- *Ancylus*

TABLE NO. 34. NUMBER OF ANIMALS ON SAND BOTTOM, EAST OF LOWER SOUTH BAY

| | | | | | |
|---|---|---|---|---|---|
| Habitat numbers | ii | iii | iv | cxxxx | Total |
| Field numbers | 701 | 700 | 705 707 | 1027 | ....... |
| Distance from shore (feet) | 6 | 5–30 | 50 | 150 | ....... |
| Depth of water (in feet) | 2 | $2\frac{1}{2}$ | 5 | 5 | ....... |
| Number of units (16 sq. in.) | 1 | 2 | 6 | 2 | 11 |
| Figures of animal life | ...... | ...... | 42 | ...... | ....... |
| Algæ | | | | | |
| *Cladophora fracta* | ...... | x | x | ...... | ....... |
| *Œdogonium* species | ...... | x | x | ...... | ....... |
| *Ulothrix subtilissima* | ...... | x | ...... | ...... | ....... |
| Mollusca | | | | | |
| *Elliptio complanatus* | ...... | 1 | ...... | ...... | 1 |
| *Sphærium vermontanum* | ...... | 10 | ...... | 1 | 11 |
| *Pisidium abditum* | ...... | 2 | ...... | ...... | 2 |
| *Pisidium compressum* | ...... | 2 | ...... | ...... | 2 |
| *Pisidium pauperculum* | 1 | ...... | ...... | ...... | 1 |
| *Pisidium scutellatum* | 1 | 4 | ...... | ...... | 5 |
| *Pisidium neglectum* | 1 | ...... | ...... | ...... | 1 |
| *Pisidium* species | 7 | ...... | ...... | ...... | 7 |
| *Campeloma decisum* | ...... | 1 | ...... | ...... | 1 |
| *Somatogyrus subglobosus* | ...... | 1 | ...... | ...... | 1 |
| *Gillia altilis* | ...... | 4 | ...... | 1 | 5 |
| *Bythinia tentaculata* | 8 | 50 | 1367 | ...... | 1425 |
| *Amnicola bakeriana* | ...... | ...... | ...... | 1 | 1 |
| *Amnicola oneida* | ...... | ...... | ...... | 2 | 2 |
| *Amnicola bakeriana nimia* | ...... | 29 | 421 | ...... | 450 |
| *Valvata tricarinata* | ...... | 2 | 285 | ...... | 287 |
| *Galba catascopium* | 1 | 3 | 18 | ...... | 22 |
| *Planorbis campanulatus* | 3 | ...... | ...... | ...... | 3 |
| *Planorbis exacuous* | ...... | ...... | 1 | ...... | |
| *Planorbis hirsutus* | 1 | ...... | ...... | ...... | 1 |
| *Planorbis parvus* | ...... | ...... | 1 | ...... | 1 |
| *Physa warreniana* | ...... | ...... | 13 | ...... | 11 |
| *Physa integra* | 2 | ...... | ...... | ...... | 3 |
| Total Mollusca | 25 | 109 | 2106 | 5 | 2245 |
| Oligochæta | | | | | |
| Naididæ | 7 | ...... | 71 | ...... | 78 |
| Tubificidæ | 2 | ...... | ...... | ...... | 2 |
| Cladocera | | | | | |
| *Eurycercus lamellatus* | ...... | ...... | 140 | ...... | 140 |
| *Simocephalus serrulatus* | ...... | ...... | 2 | ...... | 2 |
| Copepoda | | | | | |
| *Cyclops albidus* | ...... | ...... | 1 | ...... | 1 |
| Ostracoda | | | | | |
| Cyprididæ | ...... | ...... | 47 | ...... | 47 |
| Amphipoda | | | | | |
| *Gammarus fasciatus* | 1 | ...... | ...... | ...... | 1 |
| *Hyalella knickerbockeri* | 2 | 2 | 361 | ...... | 365 |
| Trichoptera | | | | | |
| *Helicopsyche borealis* | 7 | 5 | ...... | ...... | 12 |
| *Molanna* species | ...... | 1 | ...... | ...... | 1 |
| Diptera | | | | | |
| *Chironomus*, larvae-pupæ | x | x | 2 | ...... | 2 |
| *Orthocladius* species | x | ...... | ...... | ...... | x |
| *Tanytarsus* species | ...... | x | ...... | ...... | x |
| Total of x | 186 | 13 | ...... | ...... | 199 |
| Total associated animals | 205 | 21 | 624 | ...... | 850 |
| Total animal life | ...... | ...... | ...... | ...... | 3095 |

FIG. 43. Invertebrate animals on boulder bottom, on shoal north of Dunham Island, Habitat No. v, Field No. 703, water 1–3 feet deep. Life from boulder 6 x 4 x 3 inches. *Hyalella knickerbockeri* and *Helicopsyche borealis* are the principal species.

### Localities Examined in the Vicinity of Lower South Bay

Several localities outside the area of Lower South Bay were examined quantitatively and will be considered at this time. Two main localities are included; one at the west end of Dunham Island and the other the shore of the main land from Norcross Point eastward. The majority of the habitats examined have a boulder bottom.

**Dunham Island.** A wide, sandy shoal, covered by one to six feet of water, lies between Dunham and Frenchman Islands. Within the 6-foot contour there is an area containing about 38 acres. Eleven unit areas (16 square inches) were examined, the average number of mollusks being 204.09 and of associated animals 77.27, a total average of 281.36. These averages indicate a population of 3,040,434,856 mollusks and 1,151,131,370 associated animals and a total animal population of 4,191,566,226.* These figures indicate that the territory between the islands is the richest in animal life of any portion of the lake yet examined by me, having eight times as many animals per unit area as in the highest populated area of Lower South Bay (mud bottom, average 36.66 per 16 sq. in. unit). Just why this area should be so thickly populated is not known at present. The great abundance of life in this territory was clearly indicated by the examination of a small part of a submerged log (100 square feet) covered with the filamentous alga *Cladophora fracta* in which was found 2,106 mollusks and 624 associated animals, a total population of 2,730. As the log was estimated to be twelve feet long, there were present, on the basis of this average, 70,761 animals of which 54,587 were mollusks (fig. 42). The algæ bordering the shore was also filled with animals (fig. 44).

The water willow in these habitats was thickly populated with the mollusk *Bythinia tentaculata,* a single plant having from four to ten individuals, and averaging 7.66 on each

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* The computations for this population are as follows: 43,560 square feet × 144 square inches = 6,272,640 square inches, ÷ 16 square inches = 392,040 unit areas in one acre, × 38 acres = 14,897,520 units in 38 acres, × 204.09 mollusks = 3,040,434,856 mollusks and the same unit areas × 77.27 associated animals = 1,151,131,370 associated animals.

FIG. 44. Invertebrate animals in algæ on shore of Dunham Island, Habitat No. i, Field No. 701. The number of chironomid larvæ as well as the number of amphipods (*Hyalella*) is to be noted. The molluscan shells are all empty.

plant. Eight plants occupied an area eight inches square (64 square inches) and the population was therefore 61.28 per 64 square inch unit. Water willow (*Dianthera americana*) occurs in patches over the shoal area between the two islands and it is difficult without measuring each patch to estimate the total area covered by this plant. It is safe to estimate an area of 5,000 square feet which would indicate the total *Bythinia* population to be 689,400. It is probably much greater than this.

It is to be noted that on the sand bottoms *Bythinia*, *Amnicola* and *Valvata tricarinata* are the characteristic species of mollusks. Of the associated animals, *Hyalella knickerbockeri*, chironomid larvæ, and *Eurycercus lamellatus* are characteristic. The great preponderance of mollusks over associated animals (the latter being but 37.8 percent) in number of individuals is noteworthy (see Table No. 34 for the data bearing on these sand habitats).

**Shoal North of Dunham Island** (Table No. 35, Habitat No. V). North of the west point of Dunham Island there is a large shoal on which the water varies from a foot to three feet deep, the bottom being very bouldery. This shoal is upwards of 1,320 feet (a quarter of a mile) long and 200 feet wide and contains about 264,000 square feet. Animals were collected from two boulders and consisted of 55 mollusks and 237 associated animals or an average of 27.5 mollusks and 118.5 associated animals, a total population per unit of 146 individuals (see fig. 43). These figures indicate that the population of this shoal may be 33,650,897 mollusks and 145,004,776 associated animals, a total estimated population of 178,655,673.* The notable features of this locality are the small ratio of mollusks to associated animals (18.9 percent), the characteristic molluscan species being *Galba*, *Planorbis parvus*, and *Amnicola bakeriana nimia*, and the large number of *Hyalella* among the associated animals. This shoal

* The computation is: 264,000 square feet × 144 square inches = 38,016,000 square inches, ÷ 30.25 (average area of boulder) = 1,223,669 unit areas, × 27.50 mollusks = 33,650,897 mollusks and × 118.50 associated animals = 145,004,776 associated animals, the total estimated population being the sum of these two results or 178,655,673 individuals.

was examined only incidentally and the number of units is too small for a conservative estimate of the population, though it is believed that the figures here given are fairly reliable.

**South Shore of the Lake East of Norcross Point.** The territory bordering the shore east of Norcross Point is strikingly bouldery, the rocky bottom extending nearly or quite to the 6-foot contour. The shore was studied in detail for a distance of 3,700 feet eastward from the point and for a width of 200 feet, the territory embracing a square area of 740,000 feet. Ninety-four unit boulders were studied, the animal life on which totalled 290 mollusks and 1,082 associated animals, a total population of 1,372 (Table No. 35). The average per boulder was 3.08 mollusks and 11.51 associated animals, a total average population of 14.59. This unit indicates a population of 14,675,786 mollusks and 54,754,716 associated animals for this bouldery shore area or a total population of 69,430,502.* The average number of animals per boulder unit of the same size is smaller than that of the boulder area in Lower South Bay, the former being 1.85 and the latter 4.09 for mollusks. The difference is not so great for associated animals, the ratios being 6.9 and 8.37 respectively.

The table of areas examined (No. 35) shows that *Goniobasis* and *Amnicola* are the characteristic genera. *Physa, Lymnæa stagnalis lillianæ,* and *Planorbis binneyi* are also notably abundant. Among the associated animals the caddis-fly larva *Helicopsyche* is most characteristic. Chironomid larvæ lead in number of individuals followed by worms and *Hyalella.* The minute ostracods are most numerous next to the dipterous larvæ but their small size renders them relatively insignificant. The small number of mollusks (21.1 percent) as compared with the large number of associated animals (78.8 percent) is notable.

**Deep Water Habitats.** There is one area studied quantitatively still to be considered, the territory outside the 6-foot

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* The computation is as follows: 740,000 square feet × 144 square inches = 106,560,000 square inches, ÷ 22.4 (average size of boulder unit area) = 4,757,143 units, × 3.085 mollusks = 14,675,786 mollusks, and × 11.510 = 54,754,716 associated animals.

Field n

Distan
Depth
Unit b
Figures

Algæ
*Clad*
*Herp*
*Œdo*
*Phor*
*Phor*
*Scyt*
*Stige*
*Ulotl*
Mollus
*Pisi*
*Goni*
*Amn*
*Amn*
*Amn*
*Amn*
*Valv*
*Phys*
*Phys*
*Lym*
*Galb*
*Plan*
*Plan*
*Plan*
*Plan*

Turbel
*Plan*
*Plan*
Hirudi
*Glos*
*Hæn*
Oligoc
*Styl*
Nai
Cladoc
*Sida*
Ostrac
Cyp
Decap
*Cam*
Amph
*Hya*
Isopod
*Asel*
Ephen
*Hep*
Odona
*Arg*
Trichc
*Agr*
*Hel*
*Hya*
*Ithy*
*Lep*
*Lep*
*Neo*
*Œce*

## Table No. 35. Number of Animals on Boulder Bottom, East of Lower South Bay

| | v | cxxxi | cxxxii | cxxxiii | cxxxiv | cxxxv | cxxxvi | cxxxvii | cxxxviii | cxxxix | cxl | cxli | cxlii | xlii | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Habitat numbers | v | cxxxi | cxxxii | cxxxiii | cxxxiv | cxxxv | cxxxvi | cxxxvii | cxxxviii | cxxxix | cxl | cxli | cxlii | xlii | Total |
| Field numbers | 703 704 | 1028 1029 | 739–742 | 743 | 727 | 728 | 729–735 | 712 | 713 714 | 715 | 716 | 717 718 | 719–726 | 1054–1057 | |
| Distance from shore (in feet) | | 30 | 100 | 100 | 100 | 5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 1–2 | |
| Depth of water (in feet) | 1–3 | 3 | 4 | 2 | 1½ | ½ | 2½ | 3½ | 3 | 3 | 3 | 3 | 3 | ½–2 | |
| Unit boulders examined | 2 | 2 | 4 | 11 | 5 | 7 | 10 | 1 | 2 | 1 | 1 | 1 | 8 | 41 | 94 |
| Figures of animal life | 43 | | | | | | | | | * | * | | | | |
| Algæ | | | | | | | | | | | | | | | |
| *Cladophora fracta* | x | | x | | | | | | | | | | x | | |
| *Herpestiron confervicola* | | | | | | | | | | | | | x | | |
| *Oedogonium* species | | | | | | | | | | | | | x | | |
| *Phormidium retzii* | | | | | | | | | | | | | x | | |
| *Phormidium tenue* | | | | | | | | | | | | | x | | |
| *Scytonema crispum* | | | x | | | | | | | | | | x | | |
| *Stigeoclonium falklandicum* | | | | | | | | | | | | | x | | |
| *Ulothrix zonata* | x | | | | | | | | | | | | | | |
| Mollusca | | | | | | | | | | | | | | | |
| *Pisidium adamsi affinis* | | | | | | | | | | | 1 | | | | 1 |
| *Goniobasis livescens* | | 2 | 3 | 2 | 1 | | 18 | | | | | | 31 | 8 | 65 |
| *Amnicola bakeriana* | | | | | | | 3 | | | | | | | | 3 |
| *Amnicola lustrica* | 4 | | | | | | | | | | | | | | |
| *Amnicola oneida* | | | | | | | | | | | 1 | | | | 1 |
| *Amnicola bakeriana nimia* | 12 | | 2 | | | | 5 | 4 | 4 | 1 | 1 | | 68 | | 85 |
| *Valvata tricarinata* | 1 | | | | | | | | | | | | | | |
| *Physa warrenana* | 1 | | | | | | 4 | | | | | | | 18 | 22 |
| *Physa integra* | 3 | | 3 | 4 | 2 | 3 | 2 | | | | | | 17 | | 31 |
| *Lymnæa stagnalis lillianæ* | | | | | | | | | | | | | | 20 | 20 |
| *Galba catascopium* | 17 | 1 | | | | | 3 | | | | | | 2 | 3 | 9 |
| *Planorbis binneyi* | | | | | | 4 | | | | | | | | 31 | 35 |
| *Planorbis campanulatus* | | | | 4 | | | 1 | 1 | | | | | | 3 | 9 |
| *Planorbis exacuous* | | | | | | | | | 6 | 2 | | 1 | | | 9 |
| *Planorbis parvus* | 17 | | | | | | | | | | | | | | |
| Total Mollusca | 55 | 3 | 8 | 10 | 3 | 7 | 36 | 5 | 10 | 3 | 3 | 1 | 118 | 83 | 290 |
| Turbellaria | | | | | | | | | | | | | | | |
| *Planaria dorotocephala* | 1 | 1 | | | | | 2 | | | | | | 4 | | 7 |
| *Planaria maculata* | | | | | 1 | | 5 | | | | | | 10 | | 16 |
| Hirudinea | | | | | | | | | | | | | | | |
| *Glossiphonia complanata* | | | | | | | | | | | | 2 | | | 2 |
| *Hæmopis marmoratis* | | | | | | | | | | | | | | 2 | 2 |
| Oligochæta | | | | | | | | | | | | | | | |
| *Stylaria* species | 20 | | | | | | | | | | | | 1 | | 1 |
| Naididæ | 13 | | | | | | 11 | | | | | | 160 | | 171 |
| Cladocera | | | | | | | | | | | | | | | |
| *Sida crystallina* | | | | | | | 1 | | | | | | | | 1 |
| Ostracoda | | | | | | | | | | | | | | | |
| Cypridæ | | | | | | | | | | | | | 235 | | 235 |
| Decapoda | | | | | | | | | | | | | | | |
| *Cambarus propinquus* | | | | | | | 1 | | | | | | | | 1 |
| Amphipoda | | | | | | | | | | | | | | | |
| *Hyalella knickerbockeri* | 106 | | 2 | | | | | | | | | | 117 | | 119 |
| Isopoda | | | | | | | | | | | | | | | |
| *Asellus communis* | 11 | | | | | | | | | | | | 6 | | 6 |
| Ephemerida | | | | | | | | | | | | | | | |
| *Heptagenia* species, nymph | 1 | 1 | 2 | 1 | | | 3 | 1 | 1 | | | | | | 9 |
| Odonata | | | | | | | | | | | | | | | |
| *Argia putrida* nymph | | | | | 1 | | | | | | | | | | 1 |
| Trichoptera | | | | | | | | | | | | | | | |
| *Ceraclea multipunctata* | | | | | | | | | | | | | 3 | | 3 |
| *Helicopsyche borealis* | 25 | 25 | | | | | 76 | | + | | | 1 | 16 | | 122 |
| *Hydroptila* species | | | 2 | | | | | | | | | | | | 2 |
| *Ithytrichia* species | | | 2 | | | | | | | | | | 2 | | 4 |
| *Leptocerus ancylus* | 4 | 1 | 1 | | | | | | | | | | 1 | | 3 |
| *Leptocerus* species | | | | | | | 1 | | | | | | | | 1 |
| *Neophylax* species | 5 | 5 | 3 | | | | 1 | | | | | | | | 9 |
| *Œcetis incerta*? | | | 1 | | | | 1 | | | | | | | | 2 |
| *Polycentropid* larva | | | 4 | | | | | | | | | | | | 4 |
| Diptera | | | | | | | | | | | | | | | |
| *Ablabesmyia* species | | | 1 | | | | x | | | | | | x | | 1 |
| *Chironomus*, larvæ-pupæ | x | 4 | 3 | | | | x | | 3 | | 1 | | | | 11 |
| *Cricotopus* species | | | 1 | | | | | | | | | | x | | 1 |
| *Orthocladius* species | x | | | | | | | | | | | | x | | x |
| *Tanytarsus* species | x | | | | | | | | | | | | x | | |
| Total of x | 50 | | | | | | 31 | | | | | | 279 | | 310 |
| Coleoptera | | | | | | | | | | | | | | | |
| *Psephenus lecontei*, larvæ | | | 6 | | 1 | | | | | | | | 2 | | 9 |
| Acarina | | | | | | | | | | | | | | | |
| *Arrhenurus* species | 1 | | | | | | | | | | | | 1 | | 1 |
| *Atractides artoacetabula* | | | | | | | | | | | | | 8 | | 8 |
| *Hygrobates* species | | | | | | | | | | | | | 13 | | 13 |
| *Lebertia porosa* | | | | | | 4 | | | | | | | 2 | | 6 |
| *Piona* species | | | | | | | | | | | | | 1 | | 1 |
| Total associated animals | 237 | 37 | 28 | 1 | 3 | 4 | 133 | 1 | 8 | 0 | 1 | 3 | 801 | 2 | 1082 |
| Total animal life | | | | | | | | | | | | | | | 1372 |

* With some gravel

contour and east of the Lower South Bay area, and between the main land and Dunham Island, where the water gradually deepens to 19 feet. This territory, within the limits of the map, measures approximately 3,400 by 2,850 feet or 9,690,000 square feet. From the 6 dredgings (288 of the 16 square inch units) there were collected 423 mollusks and 79 associated animals or 502 in all (figs. 39–41). This is an average of 1.04 mollusks and .27 associated animals which indicates a population of 91,221,660 mollusks and 23,895,540 associated animals or a total animal population of 115,117,200 * (see Table No. 22-c).

## Comparison with Other Localities

**Oneida Lake, Survey of 1915.** It will be of interest and value to compare the results obtained by the more exact quantitative studies of 1916 with the rougher estimates of 1915. It should be borne in mind that the 1916 survey was conducted in July and the 1915 survey in September and October (Baker, '16a, pp. 121–132). It will be noted that on the average per unit area of 16 square inches the 1916 survey records exceed those of the previous year. Thus for boulder habitats, where the average for 1916 was 4.09, those for 1915 were but 2.77. The sand bottom units are 16.51 for 1916 and but 5.11 for 1915, a difference of 66 percent. In the vegetation estimates, however, the 1915 survey records are much greater than those of 1916. The average pond-lily leaf population per leaf is but 1.65 for 1916 while it was 6.33 for 1915. Again, the submerged vegetation of the 1915 survey records averaged 89 per cubic column while those of 1916 are but 76 for the same area. The comparison shows that the more careful and exact data gathered during the 1916 survey give a far better idea of the quantitative value of the animal life than do the estimates of the previous year. With the more exact data herein presented it will be possible to make com-

* The computation is as follows: 9,690,000 square feet × 144 square inches = 1,395,360,000 square inches ÷ 16 square inches = 87,210,000 units, × 1.04 mollusks = 91,221,660 mollusks, and × .27 associated animals = 23,895,540 associated animals.

prehensive comparisons with any other areas that may be studied in a similar manner.

**Comparison with Localities Outside New York State.** As few surveys from the quantitative standpoint have been made in this country, it is not possible to make extensive comparisons with other localities. A few interesting quantitative studies have been made by members of the United States Bureau of Fisheries which occur incidentally in reports of the mussel surveys of the central west, and these are of interest and value in connection with the present studies. Wilson and Clark ('12, pp. 19–20) made a count of the number of mussels in a portion of a canal (which had become dry) near Fort Wayne, Indiana. In an area 15 by 10 feet (the authors state that the width of the stream was wider than the mussel bed) 116 mussels were counted, as noted below:

| | | | |
|---|---|---|---|
| *Quadrula rubiginosa* (Lea.) | 11 | *Lampsilis ligamentina* (Lam.) | 5 |
| *Quadrula cylindrica* (Say) | 1 | *Lampsilis luteola* (Lam.) | 6 |
| *Quadrula undulata* (Barnes) | 86 | | |
| *Anodonta grandis* (Say) | 6 | Total | 116 |
| *Ptychobranchus phaseolus* (Hildreth) | 1 | | |

At another place in the canal, 10 feet square, the following species and individuals of mussels were noted:

| | | | |
|---|---|---|---|
| *Quadrula rubiginosa* (Lea) | 6 | *Anodonta grandis* (Say) | 15 |
| *Quadrula undulata* (Barnes) | 60 | *Obovaria circulus* (Lea.) | 4 |
| *Pleurobema clava* (Lam.) | 1 | *Lampsilis ligamentina* (Lam.) | 5 |
| *Alasmidonta truncata* (Wright) | 2 | *Lampsilis luteola* (Lam.) | 1 |
| *Symphynota complanata* (Barnes) | 2 | *Lampsilis ventricosa* (Barnes) | 4 |
| *Symphynota costata* (Raf.) | 5 | Total | 105 |

Another count from a square meter (10.76 square feet) of bottom gave

| | | | |
|---|---|---|---|
| *Quadrula rubiginosa* (Lea) | 9 | *Lampsilis ligamentina* (Lam.) | 2 |
| *Quadrula undulata* (Barnes) | 36 | *Lampsilis luteola* (Lam.) | 3 |
| *Symphynota complanata* (Barnes) | 1 | Total number of mussels | 81 |
| *Anodonta grandis* (Say) | 17 | | |
| *Obovaria circulus* (Lea) | 11 | *Campeloma* | 34 |
| *Lampsilis iris* (Lea) | 2 | *Pleurocera* | 23 |
| | | Total number of mollusks | 138 |

The authors note that the ground was also paved with *Sphærium* and that the area examined gave a fair average of individuals for the population of the canal.

The averages per square yard for the first two units cited are 6.9 and 9.4 respectively. The last unit, a square meter, averages 115.4 per square yard. Compared with the first two examples the Lower South Bay average of 7.8 for shallow water (1–6 feet) and 16.8 for deeper water (6–14 feet) is very favorable. In the third example, however, the average is very much greater than in any part of Oneida Lake. The gastropods in the last unit (57) are very much less in number of individuals than usually occurred in the units in Oneida Lake. As no attempt was made by the authors to count all of the animal life a comparison other than for the mussel population is not fair.

**Comparison with Marine Valuations.** It will be of interest to compare some of the numerical valuations of Oneida Lake with those of marine bottom areas. Blegvad ('17, p. 22) gives the number of animals per square meter from the bottom of two Danish habitats (Table No. 36). For comparison the animals from the 16 square inch units of two habitats (a good and a poor habitat numerically) in Oneida Lake have been listed (Table No. 37) and the number of animals have been increased to the square meter valuation (by multiplying by 96.87, the number of 16 square inch units in a square meter). It will be noted that in both Oneida Lake examples the number of animals greatly exceed those from the marine unit areas. When we compare the Oneida Lake unit valuations with the marine population per square meter of vegetation (*Zostera* plants) the number of marine animals greatly exceeds those from any similar area of fresh water yet examined by me. Blegvad ('17, p. 23) collected with a hand net over one square meter of *Zostera,* at 2 meters depth (about 6½ feet) and obtained 84,494 mollusks and 96 associated animals. Of the genus *Rissoa,* small mollusks comparable or ecologically equivalent to the *Amnicola* of Oneida Lake, two species totalled 84,420 individuals.

## Summary

The data presented in the previous pages of this chapter indicate a calculated population of 4,704,545,137 mollusks and 3,062,267,255 associated animals or a total animal population of 7,766,812,392 within the area of 1,164 acres, the total territory examined (Table No. 38). Of this amount 6,783,687,025 inhabit the bottom within the 6-foot contour and 983,125,367 occupy the territory beyond the 6-foot contour. This means that about seven billion animals live in an area of 205 acres, while nearly one billion live in 959 acres, a ratio of 33 million per acre against about one million per acre or about 33 to one. This great decrease in the number of individuals is significant, showing that *the rich life areas border the shore where the vegetation is abundant, in water from a foot to six feet in depth.* Beyond this depth the number of individuals rapidly diminish. Fish are also more abundant in species on shoals in shallow water than in the deeper parts of the lake, and the majority of young fish live in this area. This fact is graphically shown

Table No. 36. Number of Marine Animals in One Square Meter

| Depth (in feet) | Nyborg Fjord at Holckenhaven weir (bottom samples) Depth 3 feet | At Guldborg Ferry E. Dug up. Dry at ebb tide |
|---|---|---|
| *Macoma baltica* | 30 | 42 |
| *Mya arenaria* | 820 | 26 |
| *Cardium edule* | 80 | 9 |
| *Mytilus edulis* | 3580 | ........ |
| *Mytilus edulis*, juv | 380 | ........ |
| *Littorina littorea* | 140 | ........ |
| Total Mollusca | 5030 | 77 |
| *Nereis diversicolor* | 80 | 3 |
| *Arenicola marina* | ........ | 70 |
| *Gammaridæ* | 220 | ........ |
| Total associated animals | 300 | 80 |
| Total number of animals | 5330 | 150 |

in Table No. 39 where the average number of animals per unit area is indicated for the different depths. The sudden drop from the 1–6 foot to the 6–12 foot area is striking. Beyond the 6-foot contour the decrease is more gradual. This contrast between shallow and deep water is comparable to Petersen's statement that the greatest number of animals of the marine bottom per square unit is to be found in the shallow waters in the vicinity of plants ('11, p. 47).

Table No. 37. Number of Invertebrates in One Square Meter, Lower South Bay

| | 16 sq. in. unit | Equivalent 1 sq. meter | 16 sq. in. unit | Equivalent 1 sq. meter |
|---|---|---|---|---|
| Habitat number | xxv | ........ | cviii | ........ |
| Depth in feet | 4 | ........ | 3 | ........ |
| Character of bottom | sand | ........ | sand | ........ |
| *Sphærium vermontanum* | 122 | 11,818 | 4 | 388 |
| *Musculium transversum* | ........ | ........ | 2 | 193 |
| *Pisidium* species | 30 | 2,906 | ........ | ........ |
| *Amnicola bakeriana* | 18 | 1,743 | ........ | ........ |
| *Amnicola oneida* | 106 | 10,268 | 9 | 872 |
| *Bythinia tentaculata* | ........ | ........ | 1 | 96 |
| *Galba catascopium* | 20 | 1,937 | ........ | ........ |
| *Planorbis exacuous* | 2 | 193 | ........ | ........ |
| *Planorbis parvus* | 4 | 387 | 3 | 292 |
| *Planorbis antrosus* | ........ | ........ | 1 | 96 |
| *Physa integra* | ........ | ........ | 5 | 485 |
| Total Mollusks | 302 | 29,255 | 25 | 2,422 |
| *Hyalella knickerbockeri* | 2 | 193 | 4 | 388 |
| *Gammarus fasciatus* | ........ | ........ | 2 | 193 |
| *Asellus communis* | ........ | ........ | 1 | 96 |
| *Agraylea multipunctata* | 1 | 96 | ........ | ........ |
| *Molanna* species | 1 | 96 | ........ | ........ |
| *Œcetis incerta* | 1 | 96 | ........ | ........ |
| *Stylaria* species | ........ | ........ | 3 | 292 |
| Naididæ | ........ | ........ | 1 | 96 |
| Total associated animals | 5 | 484 | 11 | 1065 |
| Total number of animals | 307 | 29,739 | 36 | 3,487 |

TABLE NO. 38. ANIMAL POPULATION OF LOWER SOUTH BAY AND VICINITY

| BOTTOM | No. of units examined* | Area in acres | Animals per Unit Area | | | Total Life Examined | | | Total Population | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mollusks | Associated animals | Total | Mollusks | Associated animals | Total | Mollusks | Associated animals | Total |
| **LOWER SOUTH BAY** | | | | | | | | | | | |
| Boulder | 46 | 20 | 3.45 | 7,06 | 10.52 | 159 | 325 | 484 | 51,341,558 | 73,758,406 | 125,099,964 |
| Gravel | 34 | | 9.00 | 10.44 | 19.44 | 306 | 355 | 661 | | | |
| Sand | 143 | 85 | 16.51 | 17.70 | 34.21 | 2,361 | 2,532 | 4,893 | 550,169,334 | 590,024,120 | 1,140,193,454 |
| Sandy clay | 37 | 5 | 11.89 | 17.89 | 29.78 | 440 | 662 | 1,102 | 23,308,738 | 35,069,938 | 58,378,676 |
| Clay | 88 | 87 | 7.14 | 15.87 | 23.02 | 629 | 1,397 | 2,026 | 243,766,159 | 541,456,245 | 785,222,404 |
| Mud (1–6 feet) | 27 | 15 | 19.44 | 17.22 | 36.66 | 525 | 465 | 990 | 114,342,386 | 101,275,693 | 215,618,079 |
| Mud (6–12 feet)† | 528 | 375 | 2.07 | 1.96 | 4.04 | 1,096 | 1,039 | 2,135 | 305,203,140 | 289,178,505 | 594,381,645 |
| Mud (12–14 feet)† | 96 | 294 | 1.88 | .48 | 2.37 | 181 | 47 | 228 | 217,264,530 | 56,361,992 | 273,626,522 |
| Mussels | 28 | ...... | ...... | ...... | ...... | 447 | ...... | 447 | 9,013,265 | ...... | 9,013,265 |
| Vegetation | 40 | ...... | ...... | ...... | ...... | 155 | 35 | 190 | 9,463,428 | 355,954 | 9,819,382 |
| **VICINITY OF BAY** | | | | | | | | | | | |
| Sand (Dunham Is.) | 4 | 38 | 204.09 | 77.27 | 281.36 | 2,245 | 850 | 3,095 | 3,040,434,856 | 1,151,131,370 | 4,191,566,226 |
| Vegetation (Dunham Is.) | 1 | ...... | 7.66 | ...... | 7.66 | 23 | ...... | 23 | 689,400 | ...... | 689,400 |
| Boulder (shoal) | 2 | 6 | 27.50 | 118.50 | 146.00 | 55 | 237 | 292 | 33,650,897 | 145,004,776 | 178,655,673 |
| Boulder (Norcross Pt.) | 94 | 17 | 3.08 | 11.51 | 14.59 | 290 | 1,082 | 1,372 | 14,675,786 | 54,754,716 | 69,430,502 |
| Deep water (Norcross Pt.)† | 288 | 222 | 1.04 | .27 | 1.32 | 423 | 79 | 502 | 91,221,660 | 23,895,540 | 115,117,200 |
| Total | 1,456 | 1,164 | ...... | ...... | ...... | 9,335 | 9,105 | 18,440 | 4,704,545,137 | 3,062,267,255 | 7,766,812,392 |

* All units, excepting those for the mussels, vegetation, and the boulder shoal, are 16 square inches in area. † The large dredgings in deep water have been recalculated from 11, 2, and 6, by multiplying by 48, in order that they might be correlated with the 16 square-inch units.

TABLE NO. 39. AVERAGE NUMBER OF INVERTEBRATES PER UNIT IN RELATION TO DEPTH

*Mud Bottom*

| Depth | Mollusks | Associated animals | Total |
|---|---|---|---|
| 1–6 feet | 19.44 | 17.22 | 36.66 |
| 6–12 feet | 2.07 | 1.96 | 4.04 |
| 12–14 feet | 1.88 | .48 | 2.36 |
| 14–18 feet | 1.20 | .32 | 1.52 |

In the table of general averages per unit area (Table No. 38) it is seen that the sand bottom is the richest in individuals. The relative values of the different bottoms of Lower South Bay arranged according to number of individuals per unit area is shown in Table No. 40, where number 1 is of the greatest value. In the areas outside Lower South Bay the sand bottom is again the richest, the boulder bottom being second in numerical value. The richest area inhabited by animals in the region examined in 1916 is the sandy shoal between Dunham and Frenchman Islands. It is noteworthy

TABLE NO. 40. AVERAGE NUMBER OF INVERTEBRATES PER UNIT AREA OF BOTTOM LOWER SOUTH BAY (*Units 16 square inches*)

| Bottom | Mollusks | Associated Animals | Total |
|---|---|---|---|
| 1. Sand | 16.51 | 17.70 | 34.21 |
| 2. Sandy clay | 11.89 | 17.89 | 29.78 |
| 3. Clay | 7.14 | 15.64 | 22.79 |
| 4. Gravel | 9.00 | 10.44 | 19.44 |
| 5. Mud | 7.80 | 6.55 | 14.35 |
| 6. Boulder | 4.09 | 8.37 | 12.47 |
| *Outside Areas (Unit areas of boulders larger than 16 sq. in.)* | | | |
| 1. Sand | 204.09 | 77.27 | 281.36 |
| 2. Boulder, shoal | 27.50 | 118.50 | 146.00 |
| 3. Boulder, shore | 3.08 | 11.51 | 14.59 |
| 4. Mud, deep water | 1.04 | .27 | 1.32 |

that the mollusks outnumber the associated animals forming 57 percent of the total population. In Lower South Bay the relative proportions are reversed, the mollusks forming but 42 percent of the total population. The large preponderance of mollusks on the sand flat or shoal between the two islands is striking.

In addition to the young, immature and adult animals listed, there were vast numbers of the eggs of mollusks and associated animals which covered the vegetation in almost all localities. This is especially true of the mollusks *Amnicola, Gillia, Physa,* and *Lymnæa.* The eggs of gyrinid beetles were also very numerous on water-lily leaves. Bryozoans (*Plumatella*) thickly covered the submerged plants and bottom debris in many places and sponges abounded on stones, plants, and large objects. The Bryozoans and sponges probably have some food value although this feature has not been definitely

TABLE NO. 41. CHARACTERISTIC BOTTOM ANIMALS

| Bottom | Mollusks | Associated Animals |
|---|---|---|
| Boulder.......... | *Goniobasis*<br>*Galba catascopium*<br>*Physa warreniana* | *Helicopsyche*<br>*Hyalella*<br>........................ |
| Gravel.......... | *Sphærium vermontanum*<br>*Galba catascopium*<br>*Amnicola oneida*<br>...................... | Naididæ<br>*Hyalella*<br>*Helicopsyche*<br>Chironomid larvæ |
| Sand............ | *Sphærium vermontanum*<br>*Amnicola oneida*<br>...................... | Naididæ (*Stylaria*)<br>*Hyalella*<br>Chironomid larvæ |
| Sandy clay....... | *Amnicola oneida*<br>*Planorbis parvus* | *Hyalella*<br>Chironomid larvæ |
| Clay............ | *Amnicola oneida*<br>......................<br>...................... | *Hyalella*<br>*Asellus*<br>Chironomid larvæ |
| Mud............ | *Amnicola oneida*<br>*Planorbis parvus*<br>...................... | *Hyalella*<br>*Asellus*<br>Chironomid larvæ |

observed in Oneida Lake. Statoblasts of *Plumatella,* etc., have been found in the stomach of certain fish (Baker '16, pp. 165, 181, etc.). The molluscan eggs have a potential food value developing into the class of animals eagerly sought by many fish.

The characteristic or dominant animals on each variety of bottom, from a quantitative standpoint, are noted below and these animals may be said to characterize the community, so that we may speak of a *Goniobasis-Galba-Helicopsyche* community, an *Amnicola-Hyalella-Chironomid* community, etc.

In the area outside Lower South Bay the characteristic animals, quantitatively, are:

Boulder bottom: *Goniobasis, Amnicola bakeriana nimia, Helicopsyche, Hyalella,* Naididæ, Chironomid larvæ.
Sand bottom: *Bythinia, Amnicola bakeriana nimia, Valvata tricarinata, Hyalella,* Cladocera, Chironomid larvæ.

On the mud bottom in deeper water, the characteristic forms, numerically, are:

Table No. 42. Characteristic Animals of Deeper Water

| Depth | Mollusks | Associated Animals |
|---|---|---|
| 6–12 feet....... | *Amnicola bakeriana nimia*<br>*Amnicola bakeriana*<br>*Planorbis parvus* | Ostracoda<br>Chironomid larvæ<br>........................ |
| 13–14 feet....... | *Amnicola bakeriana nimia*<br>*Valvata sincera* | Trichoptera<br>........................ |
| 14–18 feet...... | *Amnicola bakeriana nimia*<br>*Valvata tricarinata* | *Hyalella*<br>Chironomid larvæ |

The entire area under consideration, having so heavy a covering of filamentous algæ, may be designated an algal eating community, the exception being the boulder areas where there is but little or no algæ, probably on account of wave action.

In the tables it will be noted that a characteristic species may be common in shallow water and rare in deep water and *vice versa.* The dominant species appear to occur, in this locality at least, associated with many other forms of animal life. In only a few cases were there colonies of a single or of several species. This is in contrast with marine shores, and in fact some bodies of fresh water, where one, two, or more species may cover a restricted area. Such for example are the marine genera *Littorina* and *Mya*. In rivers and lakes certain species of mussels as well as some gastropods (*Vivipara, Campeloma,* Pleuroceridæ) are confined to restricted areas.

Nearly all of the animals listed on these tables are of food value to fish. Among the mollusks all but the mussels, *Goniobasis, Campeloma, Vivipara, Gillia, Somatogyrus, Lymnæa, Pseudosuccinea, Acella* and *Segmentina* are eaten by fish of New York State. In other waters some of the excepted mollusks are also eaten. Of the associated animals, all are believed to be of food value. Among the mollusks, *Sphærium, Pisidium, Amnicola, Valvata, Planorbis,* and *Galba* are of special food value and are apparently eagerly sought by fish.

The abundance and variety of animal life in Lower South Bay recalls the animal communities of the oyster beds of the Schleswig-Holstein sea-flats described by Möbius ('83, pp. 721–722), and called by him a Biocœnosis ('83, p. 723). His description of a marine oyster-bed community or biocœnosis is of special interest in connection with the Oneida Lake animal communities. " Every oyster-bed is thus, to a certain degree, a community of living beings, a collection of species, and a massing of individuals, which find here everything necessary for their growth and continuance, such as suitable soil, sufficient food, the requisite percentage of salt, and a temperature favorable to their development. Each species which lives here is represented by the greatest number of individuals which can grow to maturity subject to the conditions which surround them, for among all species the number of individuals which arrive at maturity at each breeding period is much smaller than the number of germs produced at that time. The total number of mature individuals of all species living together in any region is the sum of the survivors of all germs which have been produced at all past breeding or brood periods; and this sum of matured germs represents a certain quantum of life which enters into a certain number of individuals, and which, as does all life, gains permanence by means of transmission."

Möbius ('83, p. 723) recognizes the fact that this biocœnosis is subject to change either by external environmental factors or by the increase, decrease, or elimination of one or more species forming the community. An interesting example is cited of the rich oyster beds of Cancale, Rochefort, Marennes, and Oléron, in France, in which the cockles (*Cardium edule*) and edible mussels (*Mytilus edulis*) replaced the oysters after the latter had been harvested for market. The oyster beds could be restocked only by removing the cockles and mussels to make room for fresh young oysters "because the ground is already occupied and the food all appropriated". Möbius further remarks that "space and food are necessary as the first requisites of every social community, even in the great seas", and this is equally true of a fresh water lake or pond.

# ANNOTATED LIST OF THE MOLLUSKS OF LOWER SOUTH BAY AND VICINITY

## General Habitat Relations

In a previous paper (Baker, '16, pp. 247–289) I have discussed the mollusks of the western end of Oneida Lake collected during the 1915 field season. Sixty-two species and races of fresh-water mollusks were listed, representing 25 genera and 11 families. During the 1916 field season 29 additional species were collected and added to the Oneida Lake list bringing the total number of species up to 91, including the Sphæriidæ not yet determined as to species. This number is greater by 25 than the total molluscan fauna listed by Maury from the Finger Lakes region ('16, pp. 29–32). One species (*Margaritana margaritifera*) previously reported is to be eliminated and another (*Lampsilis borealis*) proves not to be that species but a new race of *Lampsilis radiata* (race *oneidensis*) (Baker, '16a, pp. 74–77). A genus (*Segmentina*) is added. It is highly probable that half the species of fresh-water mollusks inhabiting the State will be found in the waters of Oneida Lake when the east end, the deep water, and the small tributary streams are examined. The additional Sphæriidæ collected in 1916 are noteworthy, bringing the total number to 32, of which 23 are of the genus *Pisidium*. The deeper water also added several species not found in 1915.

Mollusks were abundant everywhere, being absent from less than one percent of the area examined. Associated with the mollusks were worms, crustaceans, insect larvæ, and other animals, forming together a veritable microcosm, in which the majority of fresh-water groups of animals were represented, from Protozoa to Acarina. In point of numbers the mollusks usually predominated.

The quantitative method of study, by means of the examination of a large number of unit areas, has been productive of valuable results not obtained in any other way. Recently, Dr. C. G. Joh. Petersen ('15, p. 20) has made the statement quoted below which is full of meaning in connection with the study of fresh-water animals. Writing of the comparison of the animals of Danish marine waters with those of other localities he says: "It would indeed have been difficult to do so with the old method of investigation, based as it was upon dredging, and with separate treatment of each group of animals, which furnished no comprehensive view, but merely a series of long lists of the different groups. We know now, however, that it is only by investigation of the communities themselves that it is possible to arrive at a true comparison which furnishes a proper idea of the respective conditions. One might easily imagine two waters exhibiting approximately the same list of species, but yet differing in a very high degree; the frequency with which individuals of the various species occur forms a factor which cannot be disregarded."

This statement is not only true for comparative localities but holds good for different depths of the same locality; thus, we find listed the name of *Amnicola oneida* from two depths, 4 and 15 feet, but in the shallow water, its more usual habitat, 89 individuals occur in a unit area, while in the deeper water habitat only one was found. Many examples could be cited illustrating this fact showing that a *mere list* does not give a correct idea of the relations of the animals of the community.

Among the striking results obtained by the field study of Lower South Bay are the relation of the mollusks to the physical and general biological features of the area.

**1. Relation to Algæ.** One of the surprising things revealed by the detailed examination of the bay was the vast amount of filamentous algæ covering the greater part of the bottom and also the higher plants, from shore to deeper water. Among these are 10 species of *Œdogonium,* two of *Ulothrix,* two of *Spirogyra,* and a *Cladophora.* The plankton forms were also abundant. In this filamentous algæ the mollusks live in great numbers finding here unlimited quantities of food. A small quantity of *Cladophora* or *Œdogonium* would frequently form a tangled mass of mollusks, worms, insect larvæ, and crustaceans, the whole affording a tempting diet for bottom-feeding fish. The abundance of this algal food caused all of the mollusks, worms, and chironomid larvæ living in it to assume a light greenish color similar to that of the algæ. The relation of the algæ to the mollusks is shown in Tables No. 16 to 35.

The abundance of algæ was probably the cause of the comparative absence of mollusks from the larger plants — *Myriophyllum, Potamogeton, Elodea,* etc.— the algæ forming better foraging ground than the higher plants. The absence from the higher plants may also have been partly due to season, for in September of the previous year mollusks were noted in great abundance in the submerged vegetation of the outlet of the lake near Brewerton (Baker, '16, p. 129).

2. **Relation to the Bottom.** Mollusks usually clearly reflect the physical character of the environment, certain species being characteristic of a given habitat, preferring this to any other and being dominant in point of numbers. In Lower South Bay six types of bottom occur, boulder, gravel, sand, sandy clay, clay, and mud. In this bay, however, the effect of the different kinds of bottom is greatly modified by a mass of filamentous algæ which covers large areas of the bottom like a blanket and makes a uniform algal habitat over diverse kinds of bottom. That the character of the underlying stratum does play some part in the ecological distribution of mollusks in the bay is shown by the diagram (Table No. 43) where all of the species inhabiting the bay and the immediate vicinity are listed in relation to this distribution. It will be noted that 12 species live on six kinds of bottom, 10 on five kinds, 7 each on three and four kinds, 8 on two kinds, and 21 on one variety. These figures show that there is a selection of habitat based on the nature of the bottom material. The table also shows that 50 species live on a mud bottom, 42 on sand, 35 on clay, 33 on gravel, 27 on boulder, and 25 on a sandy clay bottom.

The table brings out clearly the distribution according to character of bottom and extended discussion would be superfluous. It may be well, however, to point out those species which may be said to be characteristic of each variety of bottom. In the boulder habitats *Goniobasis livescens, Lymnæa stagnalis lillianæ, Galba catascopium, Planorbis binneyi* and

## Table No. 43. Relation of Mollusks to Character of Bottom

| Character of bottom | Boulder | Gravel | Sand | Sand-clay | Clay | Mud |
|---|---|---|---|---|---|---|
| *Anodonta cataracta* | — | — | — | — | — | — |
| *Anodonta implicata* | — | | | | | |
| *Anodonta grandis footiana* | .... | — | — | — | — | — |
| *Lampsilis luteola* | — | .... | — | — | — | — |
| *Lampsilis radiata* | — | — | — | | | |
| *Lampsilis radiata oneidensis* | .... | — | — | .... | .... | — |
| *Elliptio complanatus* | — | — | — | — | — | — |
| *Sphærium solidulum* | .... | .... | .... | .... | .... | — |
| *Sphærium sulcatum* | .... | .... | .... | .... | .... | — |
| *Sphærium vermontanum* | .... | — | — | — | — | — |
| *Musculium transversum** | .... | .... | — | .... | — | |
| *Musculium truncatum* | .... | .... | .... | .... | — | |
| *Musculium* (species) | .... | — | — | — | .... | — |
| *Pisidium abditum* | .... | .... | — | .... | — | — |
| *Pisidium adamsi affine* | .... | — | | | | |
| *Pisidium complanatus* | .... | — | — | .... | .... | — |
| *Pisidium compressum* | .... | — | — | — | — | — |
| *Pisidium compressum lævigatum* | .... | .... | .... | .... | .... | — |
| *Pisidium ferrugineum* | .... | .... | — | .... | — | — |
| *Pisidium neglectum* | .... | .... | .... | .... | .... | — |
| *Pisidium overi* | .... | .... | .... | .... | .... | — |
| *Pisidium pauperculum* | .... | .... | — | .... | .... | — |
| *Pisidium punctatum simplex* | .... | .... | — | — | | |
| *Pisidium sargenti* | .... | .... | — | | | |
| *Pisidium scutellatum* | .... | — | — | — | — | — |
| *Pisidium scutellatum cristatus* | .... | — | — | — | — | — |
| *Pisidium splendidulum* | .... | .... | .... | .... | — | |
| *Pisidium variabile* | .... | — | — | — | — | — |
| *Pisidium vesiculare* | .... | .... | .... | .... | .... | — |
| *Pisidium* (species) | .... | — | — | — | .... | — |
| *Campeloma decisum* | .... | .... | — | .... | — | |
| *Vivipara contectoides* | .... | .... | .... | .... | .... | — |
| *Goniobasis livescens* | — | — | | | | |
| *Gillia altilis* | — | — | — | .... | .... | — |
| *Somatogyrus subglobosus* | — | — | — | .... | .... | — |
| *Amnicola bakeriana* | — | — | — | — | — | — |
| *Amnicola emarginata* | .... | .... | .... | .... | .... | — |
| *Amnicola limosa porata* | — | .... | — | .... | .... | — |
| *Amnicola oneida* | — | — | — | — | — | — |
| *Amnicola bakeriana nimia* | — | — | — | — | — | — |
| *Amnicola clarkei* | .... | .... | — | .... | — | — |
| *Amnicola lustrica* | — | | | | | |
| *Bythinia tentaculata* | — | — | — | .... | — | — |
| *Valvata bicarinata normalis* | .... | — | — | .... | — | — |
| *Valvata sincera* | .... | .... | .... | .... | .... | — |
| *Valvata tricarinata* | — | — | — | — | — | — |
| *Lymnæa stagnalis lillianæ* | — | | | | | |
| *Pseudosuccinea columella chalybea* | .... | .... | .... | .... | — | — |
| *Acella haldemani* | .... | .... | .... | .... | .... | — |
| *Galba catascopium* | — | — | — | — | — | — |
| *Galba humilis modicella* | .... | .... | .... | .... | — | — |
| *Galba obrussa* | .... | .... | .... | .... | — | — |
| *Planorbis antrosus* | — | — | — | — | — | — |
| *Planorbis binneyi* | — | .... | — | .... | — | |
| *Planorbis campanulatus* | — | — | — | — | — | — |
| *Planorbis deflectus* | .... | — | | | | |
| *Planorbis exacuous* | — | — | — | — | — | — |
| *Planorbis hirsutus* | — | — | — | — | .... | — |
| *Planorbis parvus* | — | — | — | — | — | — |
| *Planorbis trivolvis* | .... | .... | .... | .... | .... | — |
| *Planorbis trivolvis fallax* | — | — | — | .... | — | |
| *Segmentina armigera* | .... | .... | .... | .... | .... | — |
| *Physa integra* | — | .... | — | .... | — | — |
| *Physa warreniana* | — | — | — | — | — | — |
| *Ancylus fuscus* | .... | .... | .... | — | | |
| *Ancylus parallelus* | .... | — | — | — | — | — |
| *Ancylus* (species) | — | | | | | |
| Total species on bottom | 27 | 33 | 42 | 25 | 35 | 50 |

*Physa warreniana,* all adult or nearly so, are the dominant mollusks, and associated with these are the spiral caddis-fly larva *Helicopsyche,* the beetle larva *Psephenus lecontii,* and the May-fly nymph *Heptagenia.* In the sand between the boulders *Anodonta implicata* is characteristic. The gravel bottoms have the same species with the addition of a few species which are characteristic of a sand bottom. On a sand or clay bottom *Campeloma decisum, Musculium transversum,* and several of the *Pisidia* are dominant. On the mud bottom, which is richest in number of species, a few mollusks are characteristic, such as *Sphærium solidulum, S. sulcatum,* several *Pisidium, Amnicola emarginata, Valvata sincera,* and *Segmentina armigera.*

Another notable habitat should here be mentioned, that of the lily-pads. These cover a not inconsiderable area and afford food and lodgment for such molluscan species, as *Pseudosuccinea columella* and variety *chalybea, Physa warreniana, Ancylus parallelus,* and *Planorbis parvus. Pseudosuccinea columella* and its variety may be said to be quite characteristic of this habitat.

**3. Relation of Mollusks to Depth of Water.** From a study of Table No. 44, on which all of the species are plotted, it is seen that the number and kind of mollusk vary with the depth of water, shallow water containing the greater number of species and deeper water the less, the decrease in number being regular and gradual. Dividing the depths into seven parts we find a regular decrease as shown below:

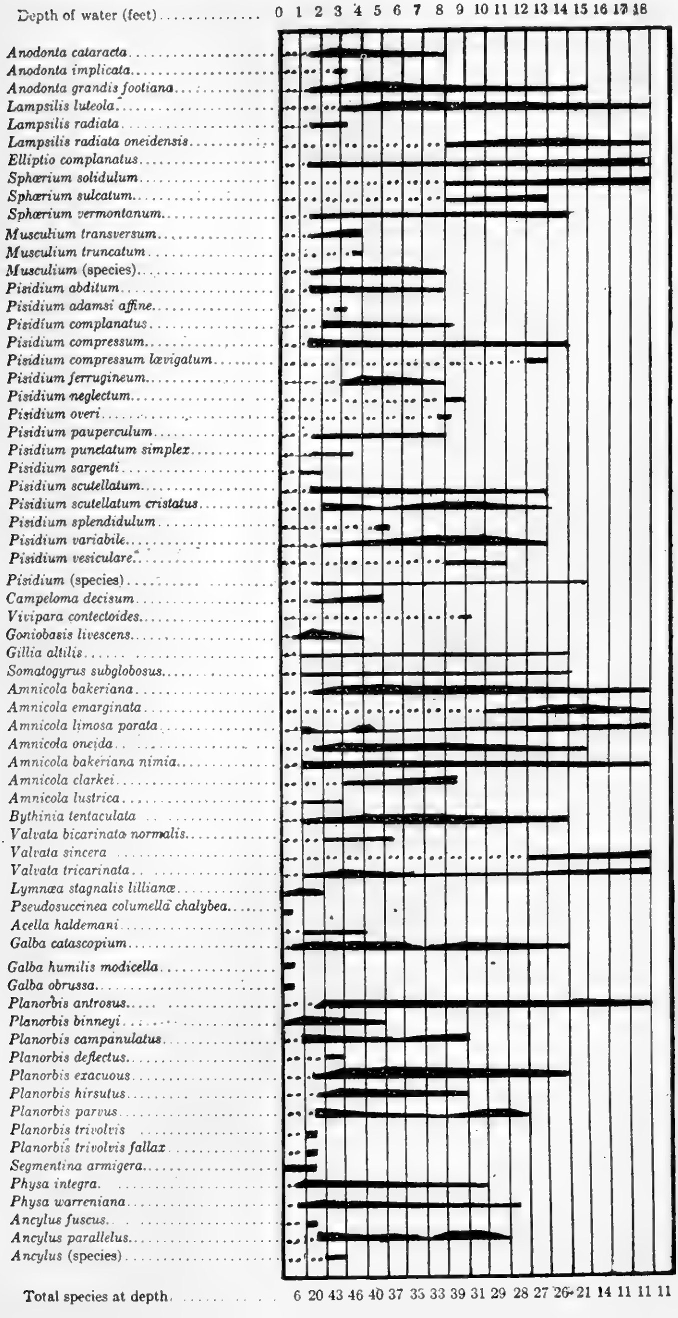
Table No. 45. Showing Decrease of Mollusks with Depth

| | | |
|---|---|---|
| Shore to 6 inches | 6 | species |
| 1 to 3 feet | 46 | " |
| 3 to 6 feet | 40 | " |
| 6 to 9 feet | 39 | " |
| 9 to 12 feet | 29 | " |
| 12 to 15 feet | 26 | " |
| 15 to 18 feet | 11 | " |

Twelve species appear to be confined to water four feet or less in depth; *Anodonta implicata, Lampsilis radiata, Musculium truncatum, M. transversum,* three *Pisidium, Lymnæa* *stagnalis lillianæ, Acella haldemani, Planorbis trivolvis, Planorbis trivolvis fallax,* and *Segmentina armigera.* It will be noted in Table No. 44 that certain depths appear to be the limit for some species and the beginning for others. Thus at eight feet, six species drop out and six species appear, while at nine feet, four additional species disappear. Two species seem to be confined to water deeper than ten feet, *Amnicola emarginata* and *Valvata sincera.*

The variation in distribution of certain species is interesting. *Lampsilis luteola* occurs at all depths beyond three feet. *Lampsilis radiata* occurs in water up to three feet in depth but its race *oneidensis* does not appear until a depth of eight feet is reached. *Anodonta implicata* appears to be restricted to water less than four feet deep while its relative, *Anodonta grandis footiana,* occurs down to 15 feet. The mussel *Elliptio* is found at all depths and on all kinds of bottom. *Sphærium vermontanum* extends from one and a half to 14 feet but its congeners *sulcatum* and *solidulum* do not appear until a depth of eight feet is reached. *Musculium* disappears at eight feet but *Pisidium* extends to 14 feet. *Goniobasis* and *Campeloma* are shallow water genera (four to five feet) while *Gillia* and *Somatogyrus* persist to a depth of 14 feet. *Valvata tricarinata* is found at all depths but its relative *Valvata sincera* does not appear until a depth of 12 feet is reached. *Amnicola bakeriana* and allied species occur at nearly all depths but *Amnicola emarginata* first occurs at a depth of 10 feet. *Amnicola lustrica* was not found in water deeper than three feet. Of the wheel-snails, *Planorbis,* seven species occur at three feet, five species at nine feet, two species at 14 feet, and but one, *Planorbis antrosus,* is found at 18 feet. *Physa* is a shallow water group, living in water one to three feet deep when adult, but occurring as deep as 11 feet when young. The disappearance of the fresh-water limpet, *Ancylus parallelus,* at 11 feet is due probably to the absence of suitable vegetation which is scanty or wanting at this depth. The paucity of plants at this and greater depths is probably one of the reasons for the diminishing number of species as the water deepens.

# Table No. 44. Relation of Mollusks to Depth of Water



Data are not at hand with which to compare the bathymetrical distribution of Oneida Lake mollusks with those of other lakes in New York. Recently, Maury, of Cornell University ('16, p. 32), reports dredgings made in deep water in Cayuga Lake but no list of species is given nor the depths attained. Dredgings were made in water as deep as 200 feet and the details of the results would be of great interest. Maury says of this work: "These dredgings proved conclusively that Mollusca are abundant from the shore line to about ten feet, after twenty-five feet thay become very scarce, the dredge yielding only a few *Amnicolas* and broken fragments of shells, the occupants having apparently been preyed upon by fishes. In the greater depths no signs of Mollusca or of plants were found. There was only a very fine grey mud entirely barren of life. We believe this to be due partly to the great depth of the Finger Lakes; but much more to the extremely low temperature of the water of Cayuga Lake, which even in midsummer is very cold except in sun-warmed shallows."

Outside of New York State, however, mollusks have been reported at considerable depths. Robertson ('15) dredged in Georgian Bay and obtained the following species at depths down to 20 fathoms (120 feet): *Amnicola limosa, A. lustrica, A. emarginata, Valvata tricarinata, V. sincera.* Walker ('97, p. 97) records *Lymnæa, Sphærium, Pisidium, Planorbis, Valvata,* and *Amnicola* as abundant at a depth of 25 metres (82 feet) in Lake Michigan near High Island.

As *Amnicola, Valvata, Sphærium,* and *Pisidium* have been found at great depths in the lakes mentioned it is highly probable that they will be found in the deepest part of Oneida Lake which attains a depth of 55 feet or more at the east end.

The distribution of mussels in depth and on character of bottom in other regions is of interest when compared with the data obtained in Lower South Bay and vicinity. Headlee and Simonton ('04, pp. 173–179) made a study of the mussels of Winona Lake, Indiana. Eight species were found, four of which inhabit Oneida Lake. The lake examined is a glacial kettle hole lake the maximum depth of which is 86 feet. The shores are as a rule " composed of sand and gravel which shade off with varying rapidity into marly sand, then into sandy dark marl that covers the bottom in all the deeper parts of the lake." The mussel zone was found to extend, as a rule, to where the bottom changed to very soft marl, averaging from four inches to nine feet deep; in some places the mud comes to within a few feet of the water's edge, while in others the sand and gravel bottom extends to water 22 feet deep. *Anodonta grandis* was found at the outer edge of the sand and gravel area, while *Strophitus edentulus* occurred a little farther out. *Grandis* sometimes occurred on a sandy bottom, but *edentulus* was always found on a soft bottom. Neither was ever found on hard sand or gravel. *Lampsilis luteola* was the most variable mussel and also the most abundant in the lake. It exhibited two color phases, light and dark, the light form being abundant in from four inches to 22 feet of water. "It is, however, dominant in shore, in weedy patches (*Potamogeton* and *Ceratophyllum*) and on *Chara*-covered bottoms. The dark variety occupies the same region but is dominant upon sand and gravel bottoms in from three and a half to 22 feet of water. The intergrading forms cover the same territory as the straw-colored and dark varieties but can not be said to be dominant anywhere." These authors conclude (p. 178) that "wave action and the muskrat determine the limit of the distribution shoreward and that the character of the bottom is the principal factor determining the outer boundary of the zone." Some very ingenious experiments are recorded testing the ability of various mussels to withstand changes of environment. It will be remembered that mussels were found in Oneida Lake at all depths examined (one to 18 feet), occurring very abundantly in soft black mud in water 8 to 18 feet deep.

In rivers and streams the mussels are found on a variety of bottoms and at varying depths. In the Illinois River at Beardstown, they occur in sand and mud in water from 10 to 12 feet deep. Above the LaGrange locks they are found on a mud bottom in 8 to 12 feet of water (Danglade, '14, p. 20). In the Cumberland River, below Livingston, the mussels occur on a rocky bottom (in clay between rocks) in a maximum depth of one and a half feet (Wilson and Clark, '14, p. 24). At various other localities in the river, mussels were found on a gravel and clay bottom in from 5 to 20 feet of water. The current was usually from two to four miles an hour.

The lakes and streams of central and northern Minnesota have been examined to some extent by the United States Bureau of Fisheries for their mussel fauna (Wilson and Danglade, '14). In Lake Minnewaska quantities of mussels (including *Lampsilis luteola* which is common in Oneida Lake) were found on a bottom of sand and rather fine gravel in water from 12 to 15 feet deep (l. c., p. 23). In Lake Benidji mussels were collected on a sand bottom, buried two and three feet deep and they were placed as thick as they could lie (p .15). In Shell River, at Twin Lakes, near Menahga, the fishermen are obliged to rake off the algæ and weeds which cover the bottom before they are able to dig the mussels, which are buried in the underlying gravel and sand to the depth of a foot or more (p. 15). These examples of buried, living mussels are interesting. Similar conditions have not been met with in Oneida Lake. For these observations a bottom sampler similar to that used by Petersen but somewhat larger is necessary to bring up the sample with the bottom layers intact. A dredge a foot square would be admirable for the purpose.

4. **Relation of Age and Season to Migrations.** It has been observed that there is a relation between the range in depth, age and season in some of the mollusks of Oneida Lake. Certain species inhabit the deeper water of the lake when young, which is usually in the spring or summer, and later in the year migrate to the shore or surface of the water. The slender pond- snail *Acella haldemani* occurs on vegetation, usually *Potamogeton*, at depths of one and a half to four feet when young (in July) and when adult, which is in August or September, it seeks the larger vegetation of the surface, or near the shore, lily-pads, rushes, pond-weeds, etc., when these plants are used for food and support. It is not definitely known whether *Acella* completes its growth in one or more years, but no adult shells could be found anywhere during July. Only young were seen and these were rare.

Another pond-snail, *Galba catascopium,* when young (June and July), inhabits the thick algæ at depths of from six to 14 feet, but when adult migrates to the shore and lives on the boulder and gravel bottoms of the exposed points and shores. It requires at least two years to complete its growth, for adults were observed on the rocky shores in July. The tadpole snails, *Physa warreniana* and *Physa integra,* also live in algæ at depths down to 10 and 11 feet when young (July), but migrate to the shore when approaching maturity (August and September), *warreniana* to inhabit (usually) rocky shores in shallow water, and *integra* the more quiet and protected habitats near the shore or surface. *Lymnæa stagnalis lillianæ* probably exhibits the same migration with age and season as do the other species mentioned, as adults are found only in the late summer and fall on the rocky shores. Half grown individuals were common in July on the boulder shores of the lake. *Planorbis binneyi* has been noted when young among algæ in five feet of water in July. In September adults are abundant in shallow water on rocky shores, in company with *Lymnæa* and *Galba.*

Additional field study will add to our information concerning this matter; but the examples cited are sufficient to clearly indicate a definite habitat relation between age, season and migration. This relation has been studied only through July, September and a part of October and it is highly desirable that early spring as well as some winter studies be made. Spring studies are especially desirable to determine the length of life of the different species of mollusks, many of which may live but a year, the stock being renewed annually. Definite information as to what species are annuals, biannuals, triannuals, etc., would be of much value in estimating the amount and rate of production of food for fish and other animals.

Adequate information is lacking concerning the periods of egg-laying among the different species of mollusks in our lakes and ponds. In Oneida Lake during the month of July the eggs of *Amnicola, Gillia, Physa,* and *Lymnæa* were noted. The egg cases of *Amnicola* covered algæ, bottom debris, vegetation, and their own as well as the shells of other species of mollusks. *Gillia* eggs were also abundant especially on ell-grass (*Vallisneria*). Eggs of the fresh-water pulmonates, *Lymnæa, Physa, Planorbis,* etc., are not as numerous in the summer as in the early fall. This abundance of eggs shows a high rate of reproduction and indicates that these genera probably reproduce themselves rapidly.

**5. Quantitative Studies.** In the chapter on the Composition of the Bottom Fauna quantitative studies have already been considered in detail so that it is only necessary here to mention those species of mollusks that are the most abundant in individuals in Lower South Bay and vicinity. *Sphærium vermontanum, Amnicola oneida, Valvata tricarinata, Galba catascopium,* and *Planorbis parvus* are the leading species in shallow water, and *Elliptio complanatus, Sphærium solidulum, Amnicola bakeriana nimia, Valvata sincera, V. tricarinata, Planorbis parvus,* and young *Galba catascopium* in the deeper water. Tables Numbers 16–35 bring out the relative abundance in a striking manner.

## List of Species

This list includes both the species collected from Lower South Bay and vicinity in 1916, and the species listed in 1915 (Baker, '16, pp. 252–286). It is thought that the complete list of species thus far recorded from the lake will be of greater value than the list of species collected in 1916 alone. Species additional to the 1915 list are indicated by an asterisk.

## CLASS PELECYPODA

### ORDER PRIONODESMACEA

### Family Unionidæ

#### Genus Elliptio Rafinesque

1. **Elliptio complanatus** (" Solander " Dillwyn).

This is the most abundant mussel in the area under discussion, being found in nearly every habitat examined, including all depths of water and all varieties of bottom. There is considerable variation in the size and form of the shell, individuals from shallow water being more typical, quadrate, while those from deeper water are more cylindrical. Shallow water individuals also have cleaner shells with brown epidermis, frequently strongly rayed anteriorly. Individuals inhabiting deeper water, especially on a mud bottom, are strongly encrusted with lime and the shells are dull black. A large percentage of small specimens (20–30 mm. long) from all depths have a green shell with dark rays. The interior of nearly all shells is purplish with either a coppery shade or with many copper spots, usually rounded in form. The difference in size between shallow water and deeper water individuals is shown in the table below:

Table No. 48. Variation in Size of Elliptio Complanatus

| | | | | |
|---|---|---|---|---|
| Length 70, | height 38, | breadth 18 mm., | 5–6 feet deep, | sand bottom. |
| Length 70, | height 35, | breadth 22 mm., | 5–6 feet deep, | sand bottom. |
| Length 66, | height 35, | breadth 20 mm., | 5–6 feet deep, | sand bottom. |
| Length 72, | height 40, | breadth 19 mm., | 2–3 feet deep, | sandy clay. |
| Length 60, | height 32, | breadth 17 mm., | 18 feet deep, | mud bottom. |
| Length 59, | height 31, | breadth 16 mm., | 18 feet deep, | mud bottom. |
| Length 63, | height 35, | breadth 18 mm., | 15 feet deep, | gravel-sand. |
| Length 56, | height 31, | breadth 14 mm., | 15 feet deep, | gravel-sand. |

All individuals of this species from the lake are smaller on the average than examples from other localities. Several gravid females were noted (July) and young shells from 3 to 20 mm. long were observed. These occurred at various depths and on different kinds of bottom, as noted in the table below:

Table No. 49. Distribution of Juvenile Elliptio

| Habitat | Bottom | Depth | No. of specimens | Size |
|---|---|---|---|---|
| cxiv.............. | sand | $1\frac{1}{2}$ feet | 1 | 12mm |
| cxlix............. | mud | $8\frac{1}{2}$ feet | 2 | 4, 10mm |
| cli............... | mud | $11\frac{1}{2}$ feet | 1 | 27mm |
| clvii............. | sand-gravel | 15 feet | 2 | $3\frac{1}{2}$, 4mm |
| " | " | 15 feet | 2 | $11\frac{1}{2}$, 13mm |
| " | " | 15 feet | 7 | 17–20mm |
| clix.............. | mud | 18 feet | 7 | 17–24mm |
| clxi.............. | mud | 14 feet | 4 | $5\frac{1}{2}$ to $10\frac{1}{2}$mm |

In a previous paper (Baker, '16, p. 252, fig. 40, no. 4) *Margaritana margaritifera* is listed from the lake. This reference was founded on a few specimens of mussels in which the lateral teeth were wanting or but feebly developed, the cardinal teeth were much reduced and the adductor muscle scars were strongly roughened. Material collected during the 1916 field season contained a number of these shells and also many with well-developed lateral teeth and other characters showing that these shell were erroneously referred to *Margaritana* and that they were abnormal or pathologic forms of *Elliptio complanatus.* Specimens were submitted to Dr. Bryant Walker who declared them to be *Elliptio.* These shells may occur in almost any lot from almost any locality. *Margaritana* is therefore to be taken from the list of Oneida Lake shells.

Genus Anodonta Lamarck

2. **Anodonta marginata** Say. Not collected in 1916.

3. **Anodonta cataracta** Say.

This characteristic paper-shell occurs in water from 3 to 8 feet deep and on all varieties of bottom. It is the commonest *Anodonta* in the bay and vicinity.

4. **Anodonta implicata** Say.

Found only on an exposed shore in water two and a half to four feet deep, in sand between boulders.

5. **Anodonta grandis** Say. Not collected in 1916.

6. **Anodonta grandis footiana** Lea.

*Footiana* occurred in water from one and a half to 15 feet deep and on all kinds of bottom, except boulder bottom.

Genus Alasmidonta Say

7. **Alasmidonta undulata** (Say). Not collected in 1916.

Genus Strophitus Rafinesque

8. **Strophitus edentulus** (Say). Not collected in 1916.

9. **Strophitus undulatus** (Say). Not collected in 1916.

Genus Lampsilis Rafinesque

**10. Lampsilis luteola** (Lamarck).

Common in water from 3 to 18 feet deep and on all varieties of bottom, except gravel.

**11. Lampsilis radiata** (Gmelin).

Found only in water from one and a half to three feet deep and on boulder, gravel, and sand bottom.

**12. Lampsilis radiata oneidensis** Baker.

Common in water from 8 to 18 feet deep and on gravel and mud bottom, usually the latter.

This mussel was previously listed (Baker, '16, p. 257) as *borealis* (Gray) but specimens of *borealis* (Latchford, '82, p. 53) from the type locality, Duck Island, Ottawa River, received from Dr. Bryant Walker, show that it is not that species, true *borealis* having a heavier, more inflated shell, heavier and differently shaped cardinal teeth and an epidermis like that of *radiata*. Small females of the Oneida Lake shell have a superficial resemblance to *Lampsilis luteola rosacea* but differ in having heavier cardinal teeth as well as in the outline of the shell, and in the color and texture of the epidermis.

This peculiar shell differes from *radiata* enough to be considered a race and the name *oneidensis* has been accordingly given to it (see Baker, '16a, pp. 74–77). This race was found only in deep water (8–18 feet) in the Lower South Bay region but in the lot collected in 1915 several shells were obtained in shallow water, though the majority of these were dead. One lot was collected in 10–16 feet of water, in the west end of the lake, with the crowfoot dredge (Baker, '16, p. 90). The shallow water individuals were evidently washed in shore from deeper water.

The *luteola* group of *Lampsilis* living in Oneida Lake is of unusual interest on account of their variation. Here the two species have apparently interbred, causing a mixture of the characters of both species. Thus, individuals of *radiata* occur with a normal hinge but with a polished surface like *luteola*. Also, *luteola* individuals occur with a rough surface and the crowded rays of *radiata*. The *radiata* of Oneida Lake are not typical, being more inflated, quadrate in outline rather than elliptical, the rays are not as even or as numerous and the color of the shell is usually yellowish rather than greenish, in this respect approaching *luteola*. Only a very few typical shells of *radiata* were collected, this type in the lake showing a decided variation toward the race herein listed as *oneidensis*.

13. **Lampsilis iris** (Lea). Not collected in 1916.

Genus Nephronajas Crosse and Fischer

14. **Nephronajas ligamentina** (Lamarck).

Diligent search failed to bring this species to light, one specimen of which was obtained in 1915 (Baker, '16, p. 259).

ORDER TELEODESMACEA

Family Sphæriidæ

Genus Sphærium Scopoli

15. **Sphærium striatinum** (Lamarck). Not collected in 1915.

16. **Sphærium vermontanum** Prime.

This is the most abundant of these small clams, occurring in water from one and a half to four feet deep and on all varieties of bottom except boulder. It is subject to some variation and, according to Dr. V. Sterki, has been little known until recently. All ages were collected, from young to mature, though the latter were rare at this time of the year (July) the majority of individuals being young or immature. It was most abundant on a sand bottom in one and a half to four feet of water.

*17. **Sphærium solidulum** (Prime).

This species occurred somewhat sparingly in water 8 to 18 feet deep on a mud bottom. Dr. Sterki characterizes it as a small eastern form.

*18. **Sphærium sulcatum** (Lamarck).

Found only on a mud bottom in 8 to 13 feet of water. It is the rarest of these small clams and is a small, slight form, quite unlike the large, heavy individuals found in other parts of New York. It is an interesting case of bathymetrical distribution that *vermontanum* should occur at all depths examined but that *solidulum* and *sulcatum* should be found only at 8 feet and deeper. The last species was obtained only between 8 and 13 feet.

Genus MUSCULIUM Link

19. **Musculium securis** (Prime). Not collected in 1916.

20. **Musculium rosaceum** (Prime). Not collected in 1916.

*21. **Musculium truncatum** (Linsley).

Found only in one habitat, on a clay bottom in four feet of water.

*22. **Musculium transversum** (Say).

This common species occurred in four habitats, on a sand and clay bottom, in water one and a half to four feet deep. It is, like some of *Sphærium,* of smaller size than is normal for the species.

*23. **Musculium** species.

A number of specimens occurred in many habitats which somewhat resemble *securis.* These are thought by Dr. Sterki to possibly represent an undescribed species. It was found in water one and a half to 8 feet deep, on gravel, sand, clay, and mud bottom.

Genus PISIDIUM Pfeiffer

*24. **Pisidium abditum** Haldeman.

Specimens of this species, or of a form very closely related to it, were found on sand, clay, and mud bottoms, in one and a half to 8 feet of water. They were small and not characteristic.

*25. **Pisidium adamsi affine** Sterki.

Collected in one habitat on a gravel bottom in three feet of water.

26. **Pisidium æquilaterale** Prime. Not collected in 1916.

*27. **Pisidium complanatum** Sterki.

Found sparingly in three habitats in water two to 8½ feet deep, on gravel, sand, and mud bottoms.

28. **Pisidium compressum** Sterki.

A small form, occurring rather plentifully in water one and a half to 14 feet deep, on gravel, sand, clay, and mud bottoms.

29. **Pisidium compressum lævigatum** Sterki.

Found only on a mud bottom in 13 feet of water.

30. **Pisidium ferrugineum** Prime.

Occurs in water three to 8 feet deep on a sand, clay, or mud bottom. It resembles eastern specimens from New England.

31. **Pisidium henslowanum** (Sheppard). Not collected in 1916.

*32. **Pisidium neglectum** Sterki.

A few quite small individuals were collected on a mud bottom in 8½ feet of water.

*33. **Pisidium overi** Sterki.

A single valve of this western species was found in a dredging from a mud bottom in 8 feet of water. This species was first described from South Dakota and was later found in Minnesota. Its occurrence in New York State extends its range far eastward.

*34. **Pisidium pauperculum** Sterki.

Collected on sand and mud bottoms in one and a half to 8 feet of water.

*35. **Pisidium punctatum simplex** Sterki.

A few specimens were found in water from one and a half to three and a half feet deep on sand and sandy clay bottoms.

*36. **Pisidium sargenti** Sterki.

A few quite small individuals were collected on a sand bottom in one and a half feet of water.

*37. **Pisidium scutellatum** Sterki.

One of the most abundant of these small clams, occurring on gravel, sand, clay, and mud bottoms in water one and a half to 13 feet deep.

*38. **Pisidium scutellatum cristatum** Sterki.

More common than the typical form and occurring usually with it on the same bottoms and depths of water.

*39. **Pisidium splendidulum** Sterki.

Specimens of this species occurred on a clay bottom in five feet of water in one habitat.

40. **Pisidium variabile** Prime.

Found in water two to 13 feet deep on gravel, sand, clay, and mud bottoms. More abundant in mud from four to 11 feet of water. The individuals are smaller than normal.

*41. **Pisidium vesiculare** Sterki.

Specimens were found in two habitats, both with mud bottoms, in 8 and 11 feet of water. While the specimens found are undoubted *vesticulare* they are not characteristic of the species.

42. **Pisidium** species. No. 217g.

43. **Pisidium** species. No. 217h.

44. **Pisidium** species. No. 217i.

45. **Pisidium** species. No. 217j.

Undetermined species of Pisidia collected in 1915 (Baker, '16, p. 263). These have not yet been classified.

*46. **Pisidium** species.

A number of small and minute Pisidia collected in 1916 are still in the hands of Dr. Sterki and await identification (see tables numbers 17–22, 34 for the field numbers). They are either peculiar forms of well-known species or are undescribed, and several species may be represented. Of the material collected in 1915 Dr. Sterki says: "You should have 30 species or more of *Sphæriidæ* in your vicinity; and there ought to be more than 20 species (plus varieties) of *Pisidium*." With the 1916 material we nearly reach Dr. Sterki's estimate of probabilities — 26 species of the family named and six unnamed. Of *Pisidium* there are 18 named species and five unnamed.

The *Sphæriidæ* of Lower South Bay consist of small individuals with slight shells and more or less weak hinges due to some physical property of the water, perhaps a lack of lime. The maximum development of this family, both in species and individuals, appears to be in comparatively deep water.

## CLASS GASTROPODA

### ORDER PROSOBRANCHIATA

### FAMILY VIVIPARIDÆ

#### Genus VIVIPARA Lamarck

47. **Vivipara contectoides** W. G. Binney.

Collected from a mud bottom in nine feet of water. Only one specimen, half grown, was found off Frenchman Island in 9 feet of water (Field No. 1031), and this was probably brought to its location by currents. This species is abundant in the west end of the lake, near Brewerton, where it lives on a sandy bottom.

#### Genus CAMPELOMA Rafinesque*

48. **Campeloma integrum** (DeKay). Not collected in 1916.

49. **Campeloma decisum** (Say).

Collected from a sand and clay bottom in water one and a half to five feet deep. More abundant on a clay bottom. The majority of the individuals of *decisum* collected in 1916 (July) were young or immature, adults being very scarce. In 1915 adults were abundant in Frederick creek, and very few immature specimens were found. It seems evident that the young of this species are born in the spring and attain their first year's growth by September or early October. Information

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* Pilsbry has recently shown that this familiar name must give way to *Ambloxis*, which is an earlier name than *Campeloma*. It is much to be regretted that this old familiar name should have to be changed in favor of the other more or less ambiguous name of Rafinesque. However, as Pilsbry remarks, if the nomenclatorial rules demand such a procedure we might as well get used to the change at once. For the sake of uniformity with the previous bulletin the old name *Campeloma* is retained for these shells. (*See* Pilsbry '17, pp. 111, 114.)

concerning the details of the breeding habits of this group of mollusks are desirable. This is the first record of this species in Oneida Lake.

### Family Amnicolidæ

#### Genus Gillia Stimpson

50. **Gillia altilis** (Lea).

Occurred on boulder, gravel, sand, and mud bottoms in one to 14 feet of water. Half-grown and adult individuals were abundant in some habitats.

#### Genus Somatogyrus Gill

51. **Somatogyrus subglobosus** (Say).

A few specimens were collected associated with *Gillia*. All were immature.

#### Genus Bythinia Gray

52. **Bythinia tentaculata** (Linn).

This common species occurred abundantly in Lower South Bay on gravel, sand, clay, and mud bottoms in water one to 14 feet deep. Most abundant on clay and mud bottoms in water four to 14 feet deep. A large percentage of the individuals collected were young or immature. *Tentaculata* is especially abundant among filamentous algæ (mostly *Cladophora fracta*), and a single specimen was collected from a leaf of *Sagittaria arifolia*. A pint of algæ, representing 100 square inches of area on an old log in five feet of water, yielded 97 adults and 1,270 young individuals of this species.

#### Genus Amnicola Gould and Haldeman

53. **Amnicola limosa** (Say).

A small form of this species occurs in the western part of Oneida Lake (Baker, '16, p. 268). No specimens were obtained with the 1916 collections.

*54. **Amnicola limosa porata** (Say).

This is the largest *Amnicola* in the lake, 5 mm. in length, with a globose body whorl and a wide umbilicus. This race of *limosa* was found only in three habitats; boulder bottom in one foot of water, sand bottom in four and a half feet of water, and mud bottom in 18 feet of water. It was most abundant on a rocky shoal in water a foot deep, a single boulder having 54 specimens.

***55. Amnicola bakeriana** Pilsbry.

This new *Amnicola* (Pilsbry, '17a, p. 44) is one of the most abundant species of the genus. Its turreted shape, elongated spire, and deep-sutured whorls differentiate it from related species. The spire varies much in length and the whorls in obesity and there are forms which are difficult to separate from elongated individuals of the form *nimia*. It occurs on all varieties of bottom, though less numerous on boulder and most abundant on sand, clay, and mud bottoms, where there is a heavy growth of algæ (*Cladophora* or *Œdogonium*). Three individuals were found on a leaf of *Sagittaria arifolia*. In depth this species is most abundant in water 3–6 feet deep and it occurs from 1 to 18 feet deep. It was dredged in great abundance on a mud bottom covered with the alga *Cladophora fracta* in 8½ feet of water. At this time of year many immature individuals occurred with the adults. *Bakeriana* was observed in the 1915 collections from the following habitats, mixed with *limosa* (Baker, '16, p. 268). Frenchman Island, No. 217-p; Shepard Point, No. 225-c; Muskrat Bay, No. 247-b; Thierre's landing, Lower South Bay, No. 280-e.

***56. Amnicola bakeriana nimia** Pilsbry.

One of the commonest varieties of this genus is a small form in which the whorls are more or less tumid below the suture, the spire is depressed, and the body whorl is swollen, giving the whole shell a wide appearance. A large specimen measures 3½ mm. in length. It occurs on all kinds of bottom in water from 1–18 feet deep, being most abundant on sandy clay or mud bottoms covered with algæ in 1–4 feet of water. About 10 per cent of the individuals collected were immature. A single specimen was collected from a leaf of the Arrow-head, *Sagittaria arifolia*. This form was observed in one lot of *Amnicola limosa* from Frenchman Island, collected in 1915 (No. 220-d).

*57. **Amnicola clarkei** Pilsbry.

This small, very narrow, subacute species occurred in but four habitats, on sand, clay, and mud bottoms, usually in algæ, in water 3–8½ feet deep. It was most abundant on a mud bottom in 8½ feet of water.

*58. **Amnicola oneida** Pilsbry.

This narrowest of the *Amnicolas* in the lake was found on all bottoms of the bay and at all depths from 1½ to 15 feet. It is not common on boulder and gravel bottoms, but on sand, clay, and mud bottoms, where there is a covering of filamentous algæ (*Cladophora, Œdogonium, Spirogyra*, etc.) in 2½ to 4 feet of water, it is the commonest mollusk in the region. Several hauls of the dredge on a mud bottom in water 8½–9 feet deep also disclosed this species in abundance, but it is not common in the deeper water, none being found deeper than 15 feet, and at this depth it was very rare. Many young and immature individuals were collected with the adult specimens.

An elongated individual of *Amnicola* related to *lustrica* was found in 1915 which seemed different from typical *lustrica* and Dr. Pilsbry suggested that special search should be made for additional material (Baker, '16, p. 269, fig. 45, no. 21). This specimen was collected near Frenchman Island on a hard sand bottom in three feet of water. The discovery of the novelty in large numbers was one of the interesting results of the 1916 field work. *Oneida* was observed in the 1915 collections from the following habitats, mixed with *lustrica*. Frenchman Island, Nos. 216-g, 217-n; Shepard Point, Nos. 225-e, 238-h; Deer Point, Big Bay, No. 234-e; Muskrat Bay, No. 247-a; Nicholson Bay, No. 262-a.

59. **Amnicola lustrica** Pilsbry.

This species was collected from but one habitat, a boulder shoal north of Dunham Island in two feet of water. Typical *lustrica* was collected near Frenchman Island in 1915 and in the western part of Oneida Lake. This species evidently does not live in the small bays.

*60. **Amnicola emarginata** (Küster).

This characteristic species occurred sparingly in water from 10 to 18 feet deep on mud and gravel bottoms, usually with the filamentous algæ *Cladophora* and *Spirogyra.*

### Family Pleuroceridæ

#### Genus Goniobasis Lea

61. **Goniobasis livescens** (Menke).

Found only on boulder and gravel bottoms, on exposed shores or points, in water one-half to four feet in depth. Most abundant in water one to two feet deep on a boulder shore. Many young and immature individuals occurred. The species as it is found in Lower South Bay varies in the obesity of the body whorl, narrow forms occurring, some with faint bands resembling the Illinois shell called *depygis* (see Baker, '02, pl. xxxv, fig. 8). The columella is deeply tinged with purple. Several young individuals were collected, having strongly keeled whorls and measuring 16 mm. in length and 7 mm. in width.

### Family Valvatidæ

#### Genus Valvata O. F. Muller

62. **Valvata tricarinata** (Say).

This small snail was found on all varieties of bottom, except sandy clay, and in all depths down to 18 feet. It occurred in numbers on a sand bottom at four feet, on a clay bottom at three and a half feet, on a mud bottom at 8, and 18 feet, and on a gravel bottom at 15 feet. It is rare on gravel and boulder bottoms in shallow water. In this area it is usually associated with the filamentous algæ *Œdogonium* and *Cladophora.* Many young and immature specimens occurred as well as some variations in the position of the carinæ. In one individual the center carina was missing on a portion of the body whorl; other individuals were very flat-spired, only the upper carina being present.

**63. Valvata bicarinata normalis** Walker.

Small forms referable to this race or variety occurred sparingly in a few habitats, on gravel, sand, clay, and mud bottoms, associated with algæ (*Cladophora*, etc.) in water two to five and a half feet deep.

***64. Valvata sincera** (Say).

*Sincera* is a deep water form and occurred on gravel and mud bottoms in water 11½ to 18 feet deep, usually associated with the alga *Cladophora fracta*. It was most abundant in water 15 and 18 feet deep.

## ORDER PULMONATA

### Family Physidæ

#### Genus Physa Draparnaud

**65. Physa warreniana** Lea.

This tadpole snail occurred on all varieties of bottom in water from one-half to eleven and one-half feet deep. It is abundant, however, only in water one-half to one and a half feet deep, and the numbers decrease with depth. A gravel or boulder bottom is the normal habitat of this species when adult, but when young or immature, as was the case with the greater part of the individuals collected (1–3 mm.), it lives in filamentous algæ (*Œdogonium, Cladophora, Spirogyra*). Of 47 lots collected but six contained adult animals. This is another species which attains its maturity in the fall, adults being abundant the previous year, in September, in shallow water where but few immature shells were seen.

Many individuals of *warreniana* occurring in Lower South Bay have the spiral sculpture reduced to a few faint lines. In some specimens this sculpture may be wanting entirely, the surface being smooth and shining. There is also some variation in the height of the spire and in the width of the shell. A few individuals are miniature examples of *Physa sayii* as figured by Binney ('65, p. 80, fig. 136). It is evident that absence of spiral sculpture is not a safe criterion alone with which to distinguish *Physa heterostropha,* for the present species, *Physa integra,* and others, are without this feature or have it but feebly developed in some specimens. As species go in *Physa warreniana* seems as distinct as many of those recognized and there is apparently no reason why it should be considered a race of *ancillaria.* It is a common species in the lakes of the middle west and probably extends eastward as do many of the fresh-water pulmonates. It is the predominating species of the genus in Oneida Lake.

**66. Physa integra** Haldeman.

*Integra* occurred on boulder, sand, clay, and mud bottoms in water one-half to ten feet deep. It was most abundant on a sand bottom in water one and a half feet deep, and on a clay bottom in two feet of water. The majority of individuals were young or immature (3–5 mm.) and were frequently associated with algæ (*Œdogonium, Chara, Nitella*) or with the larger vegetation. In the lagoon east of the steamboat wharf (Habitat No. cxv) they were found on *Potamogeton interruptus* and *Myriophyllum verticillatum.*

Considerable variation has been noted among the adult individuals of this species. Haldeman's type, figured by Binney ('65, p. 101, fig. 172) has an elongated, sharp spire and a narrow shell. In Oneida Lake this species varies from the Haldeman type to a shell with short spire and broad body whorl. *Physa billingsi* Heron, judging by examples so named by Crandall in the collection of Dr. Walker, is an absolute synonym. *Physa niagarensis* Lea may be a distinguishable variety though none were found in Oneida Lake which could be referred to this race. All of the *Physas* are in need of a thorough revision which should include an examination of available types as well as the working out of the genitalia, radulæ, and other internal organs. Full suites of the various species from many localities are also necessary.

***67. Physa heterostropha** Say.

Six young *Physas* 3–4 mm. long were collected in Tuttle Brook, a small tributary of Chittenango Creek, in a mass of algæ (*Œdogonium* and *Cladophora*). The shells are smooth and polished and are unlike the young shells of *warreniana*. They are doubtfully referred to *heterostropha*.

68. **Physa gyrina** Say. Not collected in 1916.

FAMILY ANCYLIDÆ

Genus ANCYLUS Geoffroy

69. **Ancylus parallelus** Haldeman.

This characteristic fresh-water limpet was collected from all bottoms except boulder in water one and a half to 11 feet deep, the greater number occurring on a sandy clay bottom in one and a half feet of water. In this locality it is associated with filamentous algæ (*Œdogonium* and *Cladophora*), but it is usually more abundant on such plants as *Nymphæa, Castalia, Typha, Scirpus,* and *Sparganium.*

70. **Ancylus fuscus** Adams.

Young individuals of this limpet were found in one habitat on a sandy clay bottom in one and a half feet of water.

71. **Ancylus tardus** Say. Not collected in 1916.

*72. **Ancylus** species.

A single specimen (No. 731d) of *Ancylus* was found on a boulder bottom in two and a half feet of water. It was submitted to Dr. Bryant Walker, who says of it: "I cannot be sure of the species and therefore prefer to leave it with a question until you can get more, which would be very desirable. It does not seem to be any of the more common species."

FAMILY PLANORBIDÆ

Genus PLANORBIS Müller

73. **Planorbis trivolvis** Say.

Specimens of typical *trivolvis* were found in but one habitat, a quiet lagoon on a muddy bottom in one and a half feet of water.

74. **Planorbis trivolvis fallax** Haldeman.

This form of *trivolvis,* listed in the previous paper (Baker, '16, p. 277), was again collected in 1916, on sand, boulder, gravel, and clay bottoms in water one and a half feet deep, but the majority of individuals were young or immature.

This form of *trivolvis* seems to be separable from the shell typically known as *trivolvis*. It is ecologically different, living in a more exposed habitat than does the typical form. If the large, somewhat flat form, which is a species of swamps and quiet waters, is Say's *trivolvis* then the wider-whorled form herein indicated might bear the name of *fallax* Haldeman, which evidently represents a shell of the kind figured (l. c., fig. 46, Nos. 19, 20. See also *trivolvis* Nos. 13–16 of the same figure. Compare these figures with Binney's, '65, p. 116, fig. 194, and p. 120, fig. 201). For ecological reasons it seems necessary for this form to have a name.

75. **Planorbis binneyi** Tryon.

Common on a boulder shore in one-half to one and a half feet of water. Collected on sand and clay bottoms in one and a half to five feet of water. The majority of the individuals were young or immature. Three young specimens were found on a leaf of *Sagittaria arifolia*.

76. **Planorbis antrosus** Conrad.

This *Planorbis* occurs in many habitats, on all varieties of bottom, in water from one and a half to 18 feet deep. It is more abundant at a depth of one and a half to three feet on a sand or clay bottom. It is usually associated with the filamentous algæ *Cladophora* and *Œdogonium* and is also found on floating leaves of *Potamogeton natans*. The majority of individuals secured were young or immature and the adults were smaller than is normal for the species.

77. **Planorbis campanulatus** Say.

Common on all varieties of bottom in water one to 9 feet deep. It is more abundant on a sand bottom in water one and a half to five and a half feet deep and also occurred on a mud bottom in 9 feet of water. In most habitats it is associated with filamentous algæ, either *Œdogonium, Spirogyra*, or *Cladophora fracta*. About half of the individuals collected in 1916 were young or immature and the adults were below the normal size, the greatest diameter observed being 11 and 14 mm.

78. **Planorbis parvus** Say.

This little wheel-snail occurred on all varieties of bottom in water one and a half to 12 feet deep, but was most abundant on sand, clay, and mud bottoms in water one and a half to four feet deep. It was found plentifully in one dredging in 9 feet of water on a mud bottom. It is rarest on boulder bottoms, but on a boulder shoal north of Dunham Island a stone 6 x 4 x 3 inches was covered with 15 *parvus,* adult and young. *Parvus* is usually associated with filamentous algæ (*Œdogonium, Spirogyra,* or *Cladophora*) and is frequently common on lily leaves (*Nymphæa* and *Castalia*), *Myriophyllum,* and the pond-weeds *Potamogeton interruptus* and *richardsonii.* A few specimens have been found on the arrow-head, *Sagittaria arifolia.* It is the most abundant of the whell-snails, the algæ in many places being filled with it and *Amnicola.* The majority of individuals obtained were adult, though smaller than is normal for the species.

79. **Planorbis hirsutus** Gould.

The Hairy Whell-snail occurred on all varieties of bottom, except clay, in water one and a half to 9 feet deep, but was most abundant at 3 to 4 feet on a sand bottom. It was rare on boulder and gravel bottoms. Associated with filamentous algæ, *Œdogonium, Spirogyra,* and *Cladophora,* rarest in the latter. The majority of individuals were young or immature.

*80. **Planorbis deflectus** Say.

Examples of this small *Planorbis* were found in three habitats, in but one of which it was collected alive, on a gravel bottom in two and a half feet of water. Several dead shells were collected, one of which, 5 mm. in diameter, had a well-marked median carina on the body whorl and the aperture was notably deflected. This species is apparently not common in Oneida Lake.

81. **Planorbis exacuous** Say.

Occurs on all varieties of bottom in one and a half to 15 feet of water. Most abundant on sand and mud bottoms in two to five feet of water. It is rare on a gravel bottom but is fairly common on a boulder bottom, two to four individuals being found on each boulder. Associated with the algæ *Cladophora fracta* and *Œdogonium.*

Genus Segmentina Fleming

***82. Segmentina armigera** (Say).

This species, here first recorded from the lake, was collected in two habitats, one a swampy shore in Short Point Bay among the alga *Œdogonium* and the other in a protected bay on the north side of Frenchman Island on leaves of *Sagittaria arifolia.* Both habitats are in shallow water with mud bottoms. The individuals of *armigera* are rather small.

Family Lymnæidæ

Genus Lymnæa Lamarck

**83. Lymnæa stagnalis lillianæ** Baker.

This, the largest of the gastropods in the lake, was found only at one habitat, the rocky shore of the lake east of Norcross Point, in water a few inches to two feet in depth. All were immature, half, or three-quarters grown. A single young dead shell 14 mm. in length was found in a small bay on the south shore of Long Point in water three and a half feet deep, but it had evidently been brought there from some other habitat.

In September, 1915, egg capsules of this *Lymnæa* were observed on the leaves of *Nymphæa* and *Castalia,* dead *Typha* leaves, the floating leaves of *Potamogeton natans,* and on bottom debris, and it is singular that no young individuals were observed in July, 1916 (except the dead one before mentioned). Data are not at hand bearing upon the time of hatching of the eggs laid in the fall. No young were noted in the fall of 1915. When do these eggs hatch, in the fall or in the early spring of the following year? Aquarium experiments on a large scale are necessary to provide information on these points. It seems evident that the young *lilianæ* pass their early days in deeper water, perhaps among vegetation, and later, when almost half grown, migrate to the bouldery shores. This opinion is based on the observation that the species was not seen on the shore until late in July, and none were observed in localities where they were abundant in the fall of the previous year. Early spring collecting in the lake is highly desirable.

Genus PSEUDOSUCCINEA Baker

**84. Pseudosuccinea columella** (Say). Not collected in 1916.

**85. Pseudosuccinea columella chalybea** (Gould).

Collected in but two habitats, a protected bay on *Nymphæa* leaves and a partly enclosed lagoon among filamentous algæ, *Œdogonium*. At both localities the species was fairly abundant. All individuals were immature, however, measuring from 8 to 13 mm. in length.

Genus ACELLA Haldeman

**86. Acella haldemani** ('Deshayes' Binney).

Observed in two habitats on submerged vegetation, always in a protected situation, in water from one to four feet deep.

The ecology of this, the slenderest of our *Lymnaeas,* is but little known for the greater part of the year. It has been found more or less abundantly in the fall but its whereabouts during other parts of the year is a matter of conjecture. Kirkland (Baker, '11, p. 197) believes it to be a deep water species which migrates toward shore to spawn in the fall. Sargent ('96, p. 127) found it only in the fall in Heath Lake, Minnesota, and says " where do they keep themselves in the summer." Its whereabouts in the summer can now be stated, for several specimens were found in July in Lower South Bay. The individuals were all young, none exceeding 10 mm. in length, and were invariably found on the leaves or stem of the pond-weed, *Potamogeton interruptus.* It is evident that they do not retire to deep water, but only to the zone where this pond-weed, or perhaps other suitable vegetation grows, which may be in water from two to six feet deep. The shells are very difficult to find for when living they are nearly the color of the leaf and look much like a young leaf beginning growth. The *Potamogeton* is admirably adapted for the use of this snail, its leaves being very long and exceedingly narrow and flat. It is probable from the observations of Kirkland, Sargent, and the writer that *Acella* migrates to deeper water by crawling down the stem of rooted vegetation (*Potamogeton, Scirpus,* etc.) sometime in the fall or early winter, probably when ice forms to such an extent that the surface vegetation upon which it rests and feeds is destroyed. That it will resist cold weather is shown by the observations of Kirkland, who found it on Thanksgiving Day when the ice had formed, and by the writer, who collected it in October when the water was covered with a thin film of ice in the early morning (Baker, '17, p. 135).

Genus Galba Schrank

**87. Galba catascopium** (Say).

One of the most abundant of Oneida Lake mollusks, found on all varieties of bottom in water one-half to 14 feet deep. It is most abundant on sand and mud bottoms when young and on boulder and gravel bottoms when adult. This pond-snail occurred at nearly all habitats but the majority of the individuals were very young, measuring 3 to 7 mm. They were usually associated with filamentous algæ (*Œdogonium, Cladophora,* or *Spirogyra*). *Catascopium* apparently changes its habitat with age, the young living among algæ on a mud, clay, or sand bottom, frequently in comparatively deep water (14 feet), while the adult lives usually on a boulder or gravel bottom in shallow water (one to three feet).

A single specimen was collected near Norcross Point on a sand bottom in three feet of water. The spire is very short and broad, the inner lip is broad and reflected over the umbilical region completely closing the umbilicus. The specimen measures: length 6.50, breadth 5.00, aperature length 4.50, breadth 3.00 mm. The shell is an exact duplicate, in miniature, of a form of *Galba emarginata mighelsi* from Maine, such as I have figured (Baker, '11, pl. 41, fig. 25). It is a case of parallel development.

**88. Galba emarginata** (Say).

This species was not detached in the 1916 collections. It was collected in 1915 (Baker, '16, p. 285) on a bouldery point or in a sandy, exposed bay. While collecting in the fall of 1917 the species was again encountered on the bouldery shores of Milton and Fitzgerald Points. The specimens vary from a narrow form somewhat resembling *canadensis* to the wide shell of the typical form. This species is easily distinguished from *catascopium* by the spermaciti-like color of its shell. The individuals collected in 1917 were all alive.

89. **Galba palustris** (Müller).

In 1915 a single specimen of this species was observed in a Typha habitat near the shore at Brewerton (Baker, '16, p. 286). In 1917 the true habitat of this species, in Oneida Lake, was discovered, abundantly represented by individuals. The habitat is a sandy beach, exposed to the action of the waves of the lake. This is an unusual habitat for this species which is usually found in swampy or marshy ponds or on shores well protected from violent wave action. The individuals show the effect of the environment, the shell being thick and solid and the aperature wide and bell-shaped in the majority of individuals, indicating an effort to broaden the shell to provide a better clinging power to resist the moving power of the waves. The present habitat is comparatively new, dating from the digging of the barge canal channel the debris of which was deposited on the shore of the lake. If, as may have been the case, the *palustris* occupied the old shallow area bordering the shore, the survivors would be compelled to adapt themselves to the new environment after the old, swampy shores had been obliterated. The condition of the shells, thick and solid with flaring outer lip, indicates that they are adapting themselves to a new environment, and the history outlined above seems plausable. A few specimens were also dredged some distance from the shore in water 5 feet deep near the vegetation islands. None were collected in 1916.

90. **Galba obrussa** (Say).

A single dead individual of this species was found in a dredging unit on a bar near the second lagoon east of the steamboat landing at Lower South Bay, in one and a half feet of water. It is young, 5 mm. long and had evidently been washed into this habitat from some region along the shore, which was not discovered in the time at our disposal. With *Galba humilis modicella,* this species should be found abundantly along the shore of marshy or quiet bodies of water.

91. **Galba humilis modicella** (Say).

Found in two habitats, one a lagoon among floating filamentous algæ (*Œdogonium*), the other in Tuttle Brook, a tributary of Chittenango Creek, near the shore in a few inches of water among *Œdogonium* and *Cladophora* algæ. In the latter habitat the little *Lymnaeas* were very abundant, crawling on the shore at the margin of the water or over the surface of the algæ. The specimens collected measured 5 mm. in length and were quite typical in form.

### Family Succineidæ

#### Genus Succinea Draparnaud

92. **Succinea avara** Say. Not collected in 1916.

93. **Succinea retusa** Lea.

Small specimens of this species were very abundant along the shore at Fred Becker's landing, crawling over the rocks on the shore among sedge.

### Summary

The field work of the 1916 season increased the number of species of fresh-water mollusks in the lake from 62 to 91. The relation of the species collected in 1915 to those obtained in 1916 is shown in Table No. 48

Table No. 48. Relation of Mollusks to Collecting Season

| Family | In Bay 1916 | In Lake 1915 | Total | In Bay but not elsewhere | Species new to Science |
|---|---|---|---|---|---|
| Unionidæ..... | 7 | 14 | 14 | 0 | 1 |
| Sphæriidæ ... | 23 | 14 | 32 | 18 | ......... |
| Viviparidæ... | 2 | 3 | 3 | ........ | ......... |
| Amnicolidæ .. | 11 | 8 | 11 | 3 | 4 |
| Pleuroceridæ . | 1 | 1 | 1 | ........ | ......... |
| Valvatidæ.... | 3 | 2 | 3 | 1 | ......... |
| Physidæ...... | 2 | 3 | 4 | 1 | ......... |
| Ancylidæ..... | 3 | 3 | 4 | 1 | ......... |
| Planorbidæ... | 10 | 8 | 10 | 2 | ......... |
| Lymnæidæ... | 6 | 7 | 9 | 2 | ......... |
| Total.... | 68 | 63 | 91 | 28 | 5 |

The increase in Sphæriidæ from 14 to 32 species is noteworthy. New species are recorded in the Unionidæ and Amnicolidæ. The latter family is increased from 8 to 11 species. Mollusks were collected from all varieties of bottom, boulder, gravel, sand, clay, and mud, but were most abundant on a mud bottom (50 species) and least abundant on a sandy clay bottom (25 species). Mollusks were also found at all depths being most abundant in three feet of water (46 species) and least abundant in 16–18 feet (11 species) and in very shallow water, six inches deep (6 species). A deeper water fauna was discovered in Lower South Bay and vicinity (15–18 feet deep) including such species as *Amnicola emarginata* and *Valvata sincera,* which have not been previously reported from the lake. Variation of the habitat was observed in relation to age and season, many young living in algæ in comparatively deep water in summer and in the fall migrating to shallow water near the shore. *Acella, Galba, Physa,* and *Lymnæa* were noted to exhibit this habitat migration. A striking feature of the July field work was the observation that quite the majority of the individuals were young or immature at this time of the year. It was also noted that many species were below the normal in size. This was also true of many of the associated animals. The majority of mollusks live in the filamentous algæ which covers, to a large extent, the bottom of the bay.

## INVERTEBRATES ASSOCIATED WITH THE MOLLUSCA IN LOWER SOUTH BAY AND VICINITY

### General Habitat Relations

The animal communities of Lower South Bay and its immediate vicinity include a large number of the groups of fresh-water animals, six of the phyla and 23 of the classes or higher groups being well represented. The tables in the chapter on the Composition of the Bottom Fauna indicate the kinds of animals usually associated in these communities. The remarks on quantitative methods of study with the mollusks apply equally well to the associated animals. A single dredging with the Walker dipper would usually bring up a mass of filamentous algæ fairly swarming with amphipods, isopods, chironomid larvæ, oligochæte worms, Cladocera, and gastropod mollusks, indicating a rich fauna in both species and individuals. Mollusks greatly outnumbered any other single group of associated animals in number of individuals, the total of each being about equal (9,335 mollusks and 9,105 associated animals).

As in the mollusks, the associated animals bore a definite relation to the filamentous algæ (*Cladophora, Œdogonium, Spirogyra*), these plants providing a rich and abundant food supply as well as a place of refuge from many enemies. The oligochæte worms, chironomid larvæ, and gastropod mollusks, as well as some other animals, were of the same delicate pea green tint as the algæ, due to the great quantity of this plant eaten.

**Relation to the Bottom.** Associated animals bore a definite relation to the character of bottom, though, as with the mollusks, the presence of filamentous algæ modified this character to some extent. In Table No. 49 this relation of the associated animals is shown in a diagram. We thus see that 14 species of animals live on all six varieties of bottom, 4 and 9 species respectively on five and four varieties of bottom, 17 species on three varieties of bottom, 19 species on two varieties of bottom, and 56 species are limited to one kind of bottom. Mud and sand bottoms have the greatest number of species (64 and 62 respectively), gravel the smallest number (25 species), and boulder, sandy clay, and clay bottoms almost an equal number (46, 47, 48 species respectively).

Several groups of animals are characteristic of a particular kind of bottom; thus, *Cambarus, Heptagenia, Argia, Helicopsyche,* and *Psephenus* are usually found on a boulder or gravel bottom. The great majority of associated animals inhabit sand, clay, or mud bottoms in Lower South Bay. Of the 23 higher groups represented in the collections, 18 frequented a boulder bottom, 11 gravel bottom, 19 sand, 18 sandy clay bottom, and 15 a mud bottom. A few animals were associated with vegetation, usually the water-lilies, such as the lepidopterous larvæ, and the larvæ and some adults of Coleoptera. As in the case of the Mollusca the study of the higher vegetation was unexpectedly scanty owing, probably, to the heavy growth of filamentous algæ.

**Relation to Depth of Water.** In Table No. 50 the associated animals are shown in relation to depth, from the surface to a depth of 18 feet. As with the *Mollusca* there is first an increase followed by a decrease in number of species as the depth of water increases. Dividing the depth into seven parts the following result is obtained:

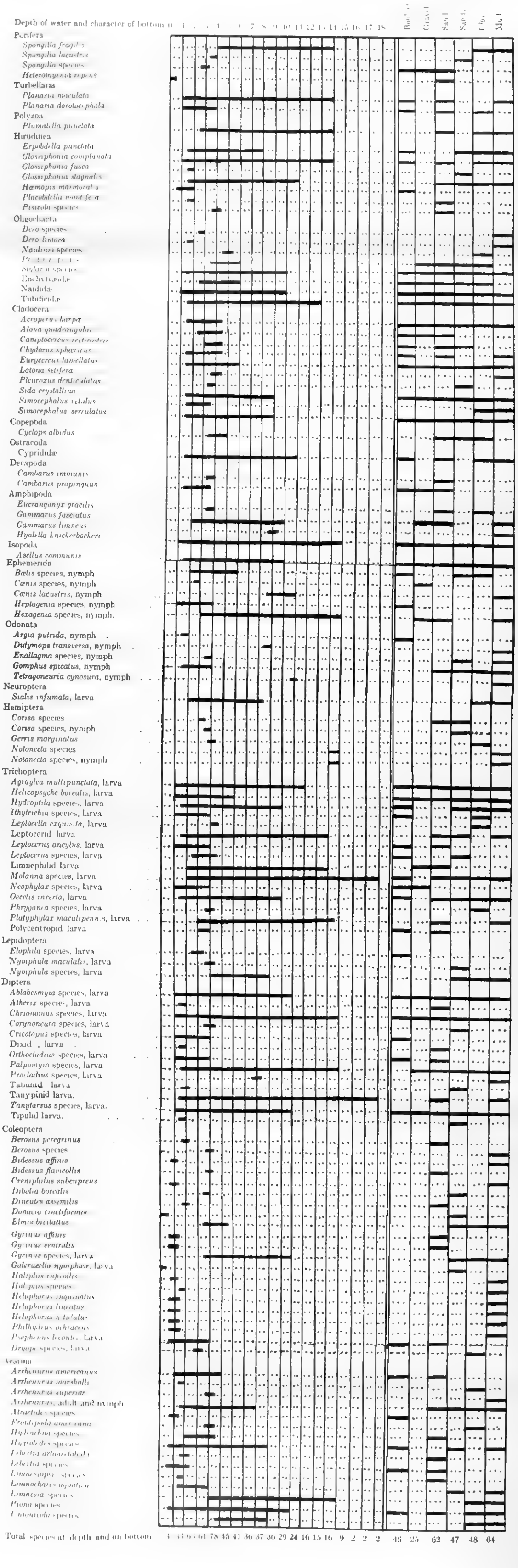
Table No. 50. Showing Decrease of Associated Animals with Depth

| | |
|---|---|
| Surface | 3 species |
| 1– 3 feet | 63 species |
| 3– 6 feet | 78 species |
| 6– 9 feet | 37 species |
| 9–12 feet | 29 species |
| 12–15 feet | 16 species |
| 15–18 feet | 2 species |

The depth at which the maximum number of species is found is thus seen to be between three and six feet. The sudden drop in depth (9–18 feet) from 29 species to 16, and then to two species in the deeper water is striking. The table also shows that a large number of species are confined to certain depths, mostly in comparatively shallow water. Only

TABLE NO. 49. RELATION OF ASSOCIATED ANIMALS TO DEPTH AND CHARACTER OF

TABLE NO. 49. RELATION OF ASSOCIATED ANIMALS TO DEPTH AND CHARACTER OF BOTTOM



a few species have a wide distribution in relation to depth, the trichopterid *Molanna* and the dipterid group Tanypinæ alone extend from shallow water to the deepest areas examined (1½ and 2 to 18 feet). These two orders have the greatest number of species and genera with a wide range in bathymetrical distribution.

**Relation to Age and Season.** Enough data are not at hand with which to discuss the relation of the associated animals to age and season. Some of the groups (as Diptera, some Crustacea) have many generations in a year while others have but one or two and in a few cases (*Sialis*) two years may be required to reach maturity. Many groups have periods of development and emergence, as the caddis-flies and May-flies, both of which had reached their maximum period before the writer began his field work (July) in 1916. Many of the associated animals differ from the Mollusca in passing through one or more stages in their development and the two groups are not, therefore, comparable in respect to their presence in season or their condition as regards age. The knowledge concerning the length of time required for attaining adult life and the number of generations in a year of the associated animals forming the food of fish is indispensable in computing the available amount of fish food in any body of water.

## Annotated List of Species

This list includes only those species and groups collected in the field work of 1916. In a number of groups (Oligochæta, Ephemerida, Trichoptera, Diptera) it has not been possible to make identifications to species, and in several cases below the family, owing to the present lack of knowledge concerning the larval stages of these groups. Rearing of these larval stages is the only means for unquestionable determination of them. The species here listed do not include all that inhabit this region, but only those that were collected arbitrarily by means of the unit area system. Systematic search for any single group would undoubtedly result in finding many additional species. The absence of Protozoa, Rhizopoda, and Infusoria from the list does not mean that these groups do not live in Lower South Bay, but that they were not sought for the present investigation. A rich fauna of these small animals probably lives in the plankton. The field numbers for the associated animals are given in Tables No. 16–35.

## PHYLUM PORIFERA

### Family Spongillidæ

**Spongilla lacustris** (Linn.). **Heteromyenia repens** Potts.

**Spongilla fragilis** Leidy.

Sponges were common in many parts of Lower South Bay, particularly on the stony points and exposed shores where *Spongilla fragilis*, of a vivid green color, covered the boulders in masses. These animals were observed living in water 2½ to 4 feet deep, but gemmules of *Spongilla fragilis* were collected at a depth of 14 feet. The three species listed are among the commonest of fresh-water sponges and are distributed generally over the United States. Dr. Harvey predicts that upwards of a dozen species will probably be found in Oneida Lake when special search is made for members of this group of animals. Identifications by Dr. Nathan A. Harvey.

During the field work of 1917, a number of sponges were collected incidentally from the west end of the lake which are of interest, including among their number one new species. These sponges were submitted to Prof. Frank Smith who determined them as follows:

**Spongilla fragilis** Leidy.

Milton Point (Field No. 1627) on stones in water 1–3 feet deep. Outlet of Oneida Lake, near Brewerton, among vegetation islands attached to *Scirpus occidentalis* (Field No. 1629) in water 5 feet deep; attached to *Najas flexilis* (Field Nos. 1631, 1634) in water 2–3 feet deep. Willow Point, Big Bay, attached to *Scirpus smithii* (Field No. 1630) in water 1 foot deep; and in outlet near Brewerton, north shore, on piece of dead limb of tree near shore (Field No. 1633).

Fitzgerald Point, west end of Oneida Lake (Field No. 1628 H), on stones in water 1–3 feet deep.

**Spongilla lacustris** (Linn.).

Fitzgerald Point, associated with *Spongilla fragilis* (Field No. 1628 D).

**Spongilla heterosclerifera** Smith, new species.

Fitzgerald Point, west end of Oneida Lake (Field No. 1628), on stones in water 1–3 feet, habitat exposed to full force of waves.

**Carterius tubisperma** Mills.

Between Zett Island and Shafer's boat landing, Brewerton (Field No. 1632), on mud bottom in water 2 feet deep.

## PHYLUM COELENTERATA

### Family Hydraridæ

**Hydra oligactis** Pallas.

This *Hydra* was common on plants, especially the large Lake Bulrush (*Scirpus occidentalis*) many leaves being covered with this animal from the bottom to within a few inches of the surface of the water. No valuation studies were made of *Hydra* in the 1916 field work, but in 1917 this animal was observed on *Scirpus occidentalis* in the vegetational island habitats near Brewerton (Baker, '16, p. 102, fig. 29) and 450 individuals counted in a space of four inches. *Hydra oligactis,* the Brown Hydra, was the only species of this group of animals observed in the west end of the lake. The species was identified by Dr. H. S. Pratt.

## PHYLUM PLATYHELMINTHES

### CLASS TURBELLARIA

### Family Planariidæ

**Planaria dorotocephala** Woodworth.

Collected on boulder and sandy clay bottoms in water one to four feet deep.

**Planaria maculata** Leidy.

Found on boulder, sandy clay, and mud bottoms in water 1–14 feet deep.

Planarian worms were abundant on boulder and sandy clay bottoms in 1–4 feet of water. They were rarest on clay and mud bottoms, and were very rare in deep water, but two specimens of *Planaria maculata* being found in water 10 and 14 feet deep. Miss Stringer comments on the lot as follows: "In two cases I feel uncertain as it is possible that they represent a third species, *Planaria gonocephala,* a form often associated with the two named. As they were in each vial merely a single specimen with the others I am inclined to believe them merely lacking in the typical pigmentation of one of the other forms." The specimens in question are Field No. 959, collected in algæ in water 3½ feet deep. Identifications by Miss Caroline E. Stringer.

## PHYLUM MOLLUSCOIDEA

### CLASS POLYZOA

#### FAMILY PLUMATELLIDÆ

**Plumatella punctata** Hancock.

This bryozoan was common in many places on sand and clay bottoms in water 3–5½ feet deep. In deeper water it occurred on a mud bottom in 8–14 feet of water. In shallow water it occurred on *Scirpus americanus, Scirpus occidentalis,* and on leaves of *Potamogeton.* Statoblasts were found abundant in plankton obtained between Norcross Point and Dunham Island, collected by Mr. A. A. Doolittle. Other species of bryozoans will probably be found when special search is made for them. *Plumatella* was identified by Dr. Paul S. Welch.

## PHYLUM ANNULATA

### CLASS HIRUDINEA

#### FAMILY GLOSSIPHONIDÆ

**Glossiphonia stagnalis** (Linn.) Johnston.

**Glossiphonia fusca** Castle.

**Glossiphonia complanata** (Linn.) Johnston.

**Placobdella montifera** Moore.

FAMILY HIRUDINIDÆ

**Hæmopis marmoratis** (Say) Moore.

FAMILY HERPOBDELLIDÆ

**Erpobdella punctata** (Leidy) Moore.

FAMILY ICHTHYOBDELLIDÆ

**Pisicola** species (No. 977).

Dr. Moore states that the individuals of these leeches are generally small for their species and many, especially *Erpobdella,* are young. *Placobdella* was collected with young adhering to the body. It will be noted that leeches occurred on all bottoms except gravel. The usual depth was from one to five feet, but two species extend to deeper water, *Glossiphonia stagnalis* to 11 feet and *Glossiphonia complanata* to 14 feet (see Table No. 47). Individuals were nowhere abundant during July, 1916. Identifications by Dr. J. Percy Moore.

CLASS OLIGOCHÆTA

FAMILY NAIDIDÆ

**Naidium** species.
**Pristina** species.
**Stylaria** species.
**Dero limosa** Leidy.
**Dero** species.

FAMILY TUBIFICIDÆ

Genera et species incertus, mostly immature.

FAMILY ENCHYTRAEIDÆ

Genera et species incertus. All immature and impossible to identify.

The oligochæte worms were very abundant in filamentous algæ and apparently living upon this plant, their bodies being of the same delicate pea green color. These worms occurred wherever algæ were found in depths down to 14 feet. The more usual depth was two to five feet. Many of the individuals of these worms are immature and identification in such cases is almost if not quite impossible. The great abundance of these animals indicates a food supply for fish of large size and ready access. Identifications by Dr. Paul S. Welch.

## PHYLUM ARTHROPODA

### CLASS CRUSTACEA

The abundance of the small crustaceans, classed generally as Entomostraca, indicates a large food supply of this important class of animals which are so much used by many fish, especially young. The food value of these small animals has already been shown (Baker, '16, pp. 298–300).

### ORDER PHYLLOPODA

#### CLADOCERA

#### FAMILY SIDIDÆ

**Sida crystallina** (Müller).
**Latona setifera** (Müller).

#### FAMILY DAPHNIDÆ

**Simocephalus serrulatus** (Koch).
**Simocephalus vetulus** (Müller).

#### FAMILY LYNCEIDÆ

**Acroperus harpæ** Baird.
**Alona quadrangularis** (Müller).
**Camptocercus rectirostris** Schdl.
**Chydorus sphæricus** (Müller).
**Eurycercus lamellatus** (Müller).
**Pleuroxus denticulatus** Birge.

The ten species of Cladocera represented in the collection are all bottom forms living for the most part in the filamentous algæ. Four species were found on all varieties of bottom. In depth two species range to 9 feet but the greatest number of species live between three and four feet in depth of water (see Table No. 49). A study of the plankton would reveal many additional species as there is probably a large plankton fauna of these. Seven species of this group were collected in 1915 that were not found in the 1916 material. Identifications by Chancey Juday.

ORDER COPEPODA

FAMILY CYCLOPIDÆ

**Cyclops albidus** Jurine.

This small crustacean was found on three varieties of bottom in $3\frac{1}{2}$–5 feet of water. The finding of but one species of copepod in the bottom collections is interesting. Dr. Marsh reports this species as being a common inhabitant of the bottom areas of lakes and other bodies of water. In the 1915 studies (mostly from the stomach contents of fish) seven species belonging to three families were noted (Baker '16, p. 300). Identified by Dr. C. Dwight Marsh.

The *Cladocera* and *Copepoda* here listed seem to belong to the littoral fauna. All but *Sida crystallina* and *Simocephalus serrulatus* (which descend to a depth of 9 feet) are confined to depths of six feet or less. All of the Entomostraca were abundant in filamentous algæ (*Cladophora, Œdogonium, Spirogyra*) associated with amphipods, oligochæte worms, isopods, chironomid larvæ, and gastropod mollusks. *Acroperus harpæ* and *Eurycercus lamellatus* were notably abundant. These small animals are of very great value as food for the young of large fish and of small fish, many of which were observed browsing on the algæ which contained these minute forms of life.

ORDER OSTRACODA

FAMILY CYPRIDIDÆ

**Cypria exsculpta** S. Fischer. **Cypridopsis vidua** (O. F. (Müller).

These two species are common in ponds, streams, and lakes. *Cypridopsis vidua* is interesting because of its scavenger habits (Sharpe, '96, p. 470). Identifications by R. W. Sharpe.

These small crustaceans, which greatly resemble in external form some of the minute mollusks belonging to the family

Sphæriidæ, were abundant in filamentous algæ associated with oligochæte worms, chironomid larvæ, amphipods, Cladocera, etc. They occurred on boulder, sand, clay, and mud bottoms, in 1½–11 feet of water. The largest number was found in Habitat No. cxlix, in 8½ feet of water, a dredging including 502 individuals. Smaller numbers were found at depths of 9 and 11 feet.

## Subclass Malacostraca

### order amphipoda

#### Family Gammaridæ

**Eucrangonyx gracilis** (Smith). **Gammarus limneus** Smith. **Gammarus fasciatus** Say.

#### Family Orchestiidæ

**Hyalella knickerbockeri** (Bate).

Of the amphipods, *Hyalella* is by far the most abundant, greatly exceeding the other species combined (see Tables 16–35). It is widely distributed as regards depth, being found in water from one to 15 feet deep. *Eucrangonyx gracilis* is the rarest species and appears to be confined to water four feet deep or less. The amphipods occur in filamentous algæ associated with other crustaceans and with oligochæte worms and chironomid larvæ (see Table No. 47). Identifications by Miss Ada L. Weckel.

### order isopoda

#### Family Asellidæ

**Asellus communis** Say.

This little isopod is very abundant in algæ associated with other crustaceans, with worms and chironomid larvæ, and gastropod mollusks. It is common in water from 1–6 feet deep, is frequent at 8 feet, and rare at 10 feet. It is also rare on boulder and gravel bottoms and is most abundant on clay bottoms in 4–5 feet of water. It is found on all varieties of bottom and its universal presence is due probably to the prevalence of filamentous algæ. The species previously recorded as *Asellus aquaticus* Linn. should be changed to *Asellus communis* which appears to be the only isopod in the lake (Baker, '16, p. 302 and elsewhere).

The *Malacostraca* group of *Crustacea* is of great importance, forming a large part of the food of many fish, both bottom-feeding and plankton-feeding forms. Their great abundance and the facility with which they move from place to place render them of first value in fish culture. Such forms as *Hyalella, Gammarus,* and *Asellus* may easily be transported from one pond to another together with their food which is chiefly filamentous algæ.

**Mancasellus tenax** (Smith).

Two specimens of this species were found in Nicholson's Bay near Brewerton (Field No. 1180 b). The habitat was a protected, pond-like body of water, separated from the open lake by a subaqueous beach-barrier covered with Water Willow (*Dianthera americana*) and Smith's Bulrish (*Scirpus smithii*). These are the first specimens found in the lake, all previous isopods having been identified as *Asellus communis.* As mentioned by Huntsman ('15, p. 148) this species is much less abundant than *Asellus* and is usually found in more open water.

This isopod is reported by Richardson ('05, p. 415) as occurring in Lake Superior, Indiana, Michigan, and Lake Huron. Huntsman ('15, p. 148) gives its range eastward to Lake Ontario (Toronto Island) and the present record extends its eastward range to Oneida Lake.

## ORDER DECAPODA

### FAMILY ASTACIDÆ

**Cambarus propinquus** Girard. **Cambarus immunis** Hagen.

With one exception, all of the crawfishes from Lower South Bay and vicinity were of one species, *Cambarus propinquus. Cambarus immunis* (No. 803) occurred sparingly on a sand bottom in 3½ feet of water. These belonged to the so-called variety *spinirostris* Faxon, the spiny condition, according to Dr. Ortmann, being characteristic of most young individuals of this species. *Cambarus* appears to be a shallow water group, none being found deeper than 3½ feet. The usual habitat for the young crawfish is a boulder or gravel bottom in 1–2 feet of water, and here they occur plentifully. They occasionally seek a sand bottom but are not as abundant in this kind of a habitat. The majority of individuals collected in July were young and two-thirds of these were females. Identifications by Dr. A. E. Ortmann.

## Class Hexapoda

### ORDER EPHEMERIDA

#### Family Ephemeridæ

**Hexagenia** species, nymph.
**Heptagenia** species, nymph.
**Bætis** species, nymph.
**Cænis** species, nymph.
**Cænis lacustris** Needham, n. s. Nymph. See Appendix.

May-fly nymphs were more or less abundant during the July field work. Earlier in the year (June) the flights of these insects were reported as enormous. Dr. Adams observed large areas of the lake where the surface of the water was completely covered by the dead bodies of May-flies. At this time the nymphs must be very abundant and the quantity per unit area would be much greater than was the case in July. The nymphs are mostly shallow water dwellers, *Hexagenia* and the new *Cænis* only descending to a depth of about 15 feet. *Heptagenia* is confined to the boulder areas, *Cænis* to the mud bottom areas. The other genera live on a variety of bottoms. The members of this order are very important as food for a number of fish. Identifications by Dr. J. G. Needham.

### ORDER ODONATA

#### Family Agrionidæ

**Enallagma** species, nymph.
**Argia putrida** (Hagen. Nymph.

Family Æschnidæ

**Gomphus spicatus** Hagen. Nymph.

Family Libelludidæ

**Didymops transversa** (Say). Nymph.

**Tetragoneuria cynosura** Say. Nymph.

With two exceptions (belonging to the Family Libellulidæ) all of the *Odonata* nymphs are inhabitants of comparatively shallow water, 1½–4 feet. In the last family, however, the nymphs were found only in deep water, 8 and 11 feet. *Gomphus* was found on all varieties of bottom except boulder and gravel, and the Libellulidæ on a mud bottom. The tables in the chapter on the Composition of the Bottom Fauna show that the Odonate nymphs are not abundant at this time of the year and it was also noted that adult dragon-flies were equally scarce. Earlier in the year they are probably much more abundant. Many dragon-fly nymphs furnish food for fish, and the group is an important one from the standpoint of fish culture. Identifications by Dr. J. G. Needham.

ORDER NEUROPTERA

Family Sialidæ

**Sialis infumata** Newman.

The larva of this insect occurred rarely in water 2½–8½ feet deep, on a clay and mud bottom. Its value as fish food is not well known. Identified by Dr. J. G. Needham.

ORDER HEMIPTERA

The aquatic Hemiptera collected were mostly in the nymph stage. The species represented were largely confined to mud and clay bottoms and to shallow water. The exception was a species of *Notonecta* (in the nymph stage) which occurred in 14 and 15 feet of water on a mud bottom. These water bugs are eaten by many fish. Identifications by Mr. Wm. J. Gerhard.

### Family Corixidæ

**Corisa** species, nymph.

**Corisa** species, adult.

### Family Notonectidæ

**Notonecta** species, adult.
**Notonecta** species, nymph.

**Plea striola** Fab. Nymph and adult.

### Family Gerridæ

**Gerris marginatus** Say.

## ORDER TRICHOPTERA

### Family Hydroptilidæ

**Agraylea multipunctata** Curtis.

**Hydroptila** species.

**Ithytrichia** species.

### Family Polycentropidæ

Polycentropid larvæ.

### Family Mollanidæ

**Molanna** species.

### Family Leptoceridæ

**Leptocella exquisita** Hagen. Pupa.

**Leptocella** (either **exquisita** Hagen or **albida** Walker).

**Leptocella.** Mostly empty cases.

**Leptocerus ancylus** Vorhees.

**Leptocerus** species.

**Œcetis incerta** Walker.

**Leptocerid** larvæ.

Many cases of *Leptocella* and Leptocerid larvæ of unknown affinities were present.

### Family Phryganeidæ

**Phryganea** species.

Family Limnephilidæ

**Neophylax** species.

**Platyphylax maculipennis** Kol.

Limnephilid larvæ.

Family Sericostomatidæ

**Helicopsyche borealis** Hagen.

Caddis-fly larvæ were abundant in several habitats, associated with chironomid larvæ, ostracods, amphipods, oligochæte worms, gastropod mollusks, etc. The group as a whole inhabited all varieties of bottom in water from 1–18 feet deep, being common in shallow water (1–4 feet), and rare in deep water (10–18 feet). *Helicopsyche* was the most abundant as regards individuals, followed by *Agraylea.* This genus of caddis-fly larvæ greatly resembles the gastropod genus *Ancylus* and has been so identified by several students not acquainted with these forms.

Of the thirteen families of Trichoptera, seven are represented in the collections. As the collecting of these insects was done just after nearly all of the species had emerged as adults, much of the material secured consisted of empty cases and tubes. Adult caddis-flies were observed flying about toward evening near the steamboat landing and under the trees near the Eastwood homestead. None were collected, however. The immature stages of but few species have been described and many of these stages would require rearing for positive identification. Caddis-flies in both the adult and larval conditions are of value as food for fish. Identifications by Dr. Cornelius Betten.

ORDER LEPIDOPTERA

Family Pyralidæ

**Nymphula maculalis** Clemens. Larva.

**Nymphula** species, larva.

**Elophila** species, larva.

The aquatic larvæ of these moths live usually on the leaves of the Yellow Water-lily, *Nymphæa advena* (or *americana*). No specimens of these larvæ were observed on the lily leaves examined by the writer but several larvæ were found in material from both clay and mud bottoms. A single larva of *Nymphula* was found at a depth of nine feet on a mud bottom. *Elophila* was collected on a boulder bottom in shallow water. The larvæ collected in these bottom deposits were evidently washed from their usual habitat on the lily leaves and sank to the bottom (see Welch, '16, p. 171, etc.). Dr. Welch has made a study of these aquatic larvæ from parts of Oneida Lake and his report will contain a full account of these interesting insects. Identifications by Dr. Paul S. Welch.

## ORDER DIPTERA

### Family Tipulidæ

A single larva belonging to this family was found in a lot of oligochæte worms examined by Dr. Welch (Habitat No. lxxxvii, Field No. 966, sandy clay bottom, water 1½ feet deep).

### Family Dixidæ

A larva of this family was observed with oligochæte worms submitted to Dr. Welch (Habitat No. lvi, Field No. 889, sand bottom, water 1½ feet deep).

### Family Chironomidæ

**Palpomyia** (sens. lat.) species.
**Procladius** species.
**Corynoneura** species.
**Chironomus** species.
**Tanytarsus** species.
**Cricotopus** species.
**Orthocladius** species.
**Ablabesmyia** species.
Genus incertus.

### Family Leptidæ

**Atherix** species (No. 889–893).

### Family Tabanidæ

A larva of this family was found with oligochæte worms by Dr. Welch (Habitat No. lxxxix, Field No. 944, sandy clay bottom, water 2 feet deep).

The identification of chironomid larvæ is attended with difficulty owing to the present lack of knowledge concerning these early stages of the midges. It has been possible to identify these forms only as far as the genera, for this reason. Rearing the larvæ contained in this body of water would add greatly to our knowledge of this subject. The larvæ of these midges, especially of *Chironomus,* were very abundant in filamentous algæ, associated with caddis-fly larvæ, oligochæte worms, small crustaceans, and gastropod mollusks. They occurred on all varieties of bottom, being most abundant on sand and least abundant on gravel bottoms. In depth, *Chironomus* and *Palpomyia* descend to 15 feet and the Tanypinæ to 18 feet. The majority of larvæ, however, were found at depths ranging from one to four feet. Identifications mostly by Dr. O. A. Johannsen.

### ORDER COLEOPTERA

#### Family Dytiscidæ

**Bidessus flavicollis** Lec.
**Bidessus affinis** Say.

#### Family Haliplidæ

**Haliplus ruficollis** DeG.
**Haliplus** species.

#### Family Gyrinidæ

**Gyrinus affinis** Aubé.
**Gyrinus** species (larva).
**Gyrinus ventralis** Kirby.
**Dineutes assimilis** Aubé.

#### Family Hydrophilidæ

**Helophorus nitidulus** Lec.
**Helophorus lineatus** Say.
**Helophorus inquinatus** Mann.
**Philhydrus ochraceus** Mels.
**Creniphilus subcupreus** Say.
**Berosus peregrinus** Hbst.
**Berosus** species.

#### Family Parnidæ

**Psephenus lecontei** Lec. (larva).
**Dryope** species (larva).
**Elmis bivittatus** Lec.

### Family Chrysomelidæ

**Donacia cinctiformis** Newm. With eggs on leaf of *Nymphæa*.

**Galerucella nymphaeae** Linn. Larva.

**Dibolia borealis** Chev.

The Coleoptera are better represented, as far as number of species is concerned, than any group of the associated animals, 21 species being included in the list. They are confined mostly to shallow water (surface to four feet) and to clay, mud, and sand bottoms. The larva of *Gyrinus*, however, was collected at a depth of 11 feet. The small beetles were associated with filamentous algæ in which several species were very abundant. Gyrinid beetles (*Gyrinus affinis* and *Gyrinus ventralis*) were notably abundant in the quiet water of Short Point Bay where they formed great masses on the surface, sometimes over an area of 20 square feet. The larvæ of *Psephenus* were very abundant on boulders associated with the May-fly nymphs (Matheson, '14, pp. 185–188), *Heptagenia*, and the mollusks, *Galba* and *Goniobasis*. The Chrysomelid beetles and larvæ were observed on the leaves of the Water-lily, *Nymphæa advena* (identified by Dr. Welch). Identifications mostly by Mr. Wm. J. Gerhard.

## Class Arachnoidea

### Order Acarina

### Family Hydrachnidæ

**Hydrachna** species.

### Family Limnocharidæ

**Limnochares aquaticus** (L.).

### Family Hygrobatidæ

**Arrhenurus americanus major** Marshall.
**Arrhenurus marshalli** Piersig.
**Arrhenurus superior** Marshall.
**Arrhenurus** species (adult and nymph).
**Lebertia artaacetabula** Marshall.
**Lebertia porosa** Lebert.
**Limnesia** species.
**Limnesiopsis** species.
**Frontipoda americana** Marshall.
**Unionicola** species.
**Piona** species.
**Atractides artaacetabula** Marshall.
**Hygrobates** species.

Water mites were abundant in a few habitats in filamentous algæ, associated with chironomid larvæ, small crustaceans, oligochæte worms, and gastropod mollusks. They were found on all bottoms except gravel and were most abundant on boulder and least abundant on sandy clay bottoms. The majority of mites were found in water from one to four feet deep, but a few individuals of *Hygrobates, Unionicola, Piona, Limnesia,* and *Arrhenurus* extended to a depth of 8–15 feet. Identifications by Miss Ruth Marshall.

### Summary

The preceding list of associated animals includes 21 groups higher than families, 48 families, 93 genera, and 76 identified and 54 unidentified (by genera only) species, a total of 130 species. A new species of *Cænis* and a new *Spongilla* were discovered. The relation of these species to the higher groups is shown in Table No. 51.

The material collected in 1915 contained 61 genera, and 54 identified and 23 unidentified species, a total of 77 species. The superiority of the unit area method of collecting is here demonstrated. Of the unidentified material contained in the 1916 collections, many of the genera contain several species so that there are probably double the number of species here recorded. It is possible that as many as 250 species are really represented in these collections of 1916. The majority of these animals are of value as food for fish.

In the previous chapters, 36 species of seed plants, 44 species of algæ, and 90 species of mollusks have been recorded, making a grand total, with the associated animals, of 300 species. As there are several species among the unidentified groups it is safe to say that upwards of 400 species are represented in the bottom collections from Lower South Bay and vicinity.

It was noted that in several groups of associated animals, as well as in a few genera of mollusks, the individuals were smaller than the normal size, although no reason is at present known why this should be so. The Hirudinea, Odonata, and *Cambarus* contained several species showing this.

TABLE NO. 51. GENERA, SPECIES, AND HIGHER GROUPS OF ASSOCIATED ANIMALS FROM LOWER SOUTH BAY AND VICINITY

| Group | Families | Genera | Species | | Genera unknown |
|---|---|---|---|---|---|
| | | | Identified | Unidentified | |
| *Porifera*...... | 1 | 3 | 5 | 1 | 0 |
| *Hydrozoa*..... | 1 | 1 | 1 | 0 | 0 |
| *Turbellaria*... | 1 | 1 | 2 | 0 | 0 |
| *Polyzoa*...... | 1 | 1 | 1 | 0 | 0 |
| *Hirudinea*.... | 4 | 5 | 6 | 1 | 0 |
| *Oligochæta*.... | 3 | 4 | 1 | 4 | 2 |
| *Cladocera*..... | 3 | 9 | 10 | 0 | 0 |
| *Copepoda*..... | 1 | 1 | 1 | 0 | 0 |
| *Ostracoda*..... | 1 | 2 | 2 | 0 | 0 |
| *Decapoda*..... | 1 | 1 | 2 | 0 | 0 |
| *Amphipoda*... | 1 | 3 | 4 | 0 | 0 |
| *Isopoda*...... | 1 | 1 | 1 | 0 | 0 |
| *Ephemerida*.. | 1 | 4 | 1 | 4 | 0 |
| *Odonata*...... | 3 | 5 | 4 | 1 | 0 |
| *Neuroptera*... | 1 | 1 | 1 | 0 | 0 |
| *Hemiptera*.... | 3 | 4 | 2 | 4 | 0 |
| *Trichoptera*... | 7 | 11 | 6 | 8 | 3 |
| *Lepidoptera*.. | 1 | 2 | 1 | 2 | 0 |
| *Diptera*....... | 4 | 9 | 0 | 9 | 4 |
| *Coleoptera*.... | 6 | 14 | 17 | 4 | 0 |
| *Acarina*...... | 3 | 11 | 8 | 7 | 0 |
| Totals... | 48 | 93 | 76 | 45 | 9 |

## RELATION OF THE FOOD SUPPLY TO THE FISH POPULATION OF LOWER SOUTH BAY

"When we consider that the modern — or rather quite recent — investigations which I have called Valuation Investigations date back but some few years, and that it has been necessary to invent entirely new apparatus for the study of marine bottom fauna, it will readily be recognized that these investigations are as yet only in their infancy, and far from being completed. We still lack figures of the annual production of the various species of animals in different waters, and in many cases it may be that such figures will be difficult to procure at all."

PETERSEN '15, p. 29.

In the chapter on the Composition of the Bottom Fauna the mass of animal life per square unit of bottom and for the entire area examined (during the month of July) has been given. The value of this invertebrate life to the fish fauna as food is the object sought in this investigation. We wish to know how many food and game fish this amount of animal life will support. This problem is complicated because of the diversity of food habits among the fish population. A number of fish are vegetable eaters, some are predaceous, living on other smaller fish, but the great majority subsist upon the animals noted in the previous pages, and even those fish living on other fish depend in the ultimate analysis upon invertebrate animals through the food of the fish preyed upon. Before considering the intimate relation between the food supply and the fish fauna it will be necessary to know something of the annual production of this dependent life, and of the animals other than fish, that also prey upon this life.

### FOOD HABITS OF INVERTEBRATE ANIMALS

Blegvad ('15, pp. 41–78) has carefully studied the general conditions and food among the communities of the invertebrate animals inhabiting the bottom of Danish marine waters. This writer made stomach examinations of nearly all the common invertebrate animals living on the sea bottom (pp. 52–73); many specimens of each species were studied. As a result of these investigations the animals of this region are divided into herbivores, detritus eaters, and carnivores. The Danish investigators, headed by Dr. Petersen ('11, '13, etc.) have laid great stress upon the value of the bottom material, called by Petersen "dust-fine-detritus" (see Baker, '16, pp. 114–120; also Petersen, '11, p. 6) as food for many animals, especially the invertebrates. Blegvad sums up his investigations in the following words: "Detritus forms the principal food of nearly all the invertebrate animals of the sea bottom, next in order of importance being plant food from fresh benthos plants. The value of live phytoplankton in this connection is absolutely minimal, amounting in any case to nothing more than an indirect significance through the medium of the plankton cocepods."

Blegvad also sums up his results in a very interesting table (p. 74) in which the various bottom inhabiting animals are listed according to their food habits. Although the fresh-water animals of Oneida Lake are not subject to exactly the same conditions as the marine animals of the Danish waters, they are nevertheless subject to the same method of treatment, and in Table No. 52 they are listed following the method of Blegvad. It is to be noted that this table is provisional, many of the groups not having been sufficiently studied as to their food habits. The table may serve to form the basis for future work.*

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* The terms used in the table have the following meaning:

*Detritus eaters.* Living on the animal and vegetable matter held in suspension in the water or deposited on the bottom, including some plankton and some carrion.

*Herbivorous-detritus eaters.* Living on both plants and detritus. Eat carrion also.

*Herbivorous and carnivorous.* Living on both fresh animals and fresh plants.

*Carnivorous-detritus eaters.* Eating carrion as well as fresh animal food.

*Carnivorous eaters.* Living only on fresh animal food.

*Herbivorous eaters.* Living only on fresh plants.

By detritus is understood "such dead or dying (decomposing) organisms or portions of same, whether of vegetable or animal origin, as are found in suspension (or solution) in the sea water or deposited on the bottom." It is believed that the fine dust-like covering of the bottom deposits in our lakes, together with the fragments of plants and animals, is homologous with the detritus thus characterized by Blegvad.

TABLE NO. 52. FOOD HABITS OF INVERTEBRATE ANIMALS*

| Detritus | Herbivorous-detritus | Herbivorous | Carnivorous-detritus | Herbivorous and carnivorous | Carnivorous |
|---|---|---|---|---|---|
| Unionidæ * | *Vivipara* * | Amnicolidæ ** | *Cambarus* ** | *Lymnæa* * | Odonata ** |
| Sphæriidæ ** | *Campeloma* * | Planorbidæ * | *Lymnæa* * | *Galba* (large) ** | Neuroptera (larvæ) |
| Porifera | *Goniobasis* | Ancylidæ * | *Galba* (large) ** | *Cambarus* ** | Dytiscidæ (larvæ) * |
| Bryozoa * | Physidæ * | Valvatidæ ** | Hirudinea * | *Tanypus* (larva) | Gyridinæ (larvæ) * |
| Ostracoda * | Amphipoda ** | *Galba* (small) * | | Isopoda * | Adults of same * |
| Copepoda (bottom) ** | Chironomid (larvæ) ** | *Acella* | | *Planaria* | *Gerris* * |
| Cladocera ** | Oligochæta * | *Pseudosuccinea* | | | Notonectidæ * |
| | *Corisa* * | Ephemerida ** (nymphs) | | | Haliplidæ |
| | *Tanypus* | Lepidoptera * (larvæ) | | | Hirudinea * |
| | Trichoptera (larvæ) * | *Donacia* (larvæ) | | | Hydrophilidæ |
| | Ostracoda * | *Galerucella* (larvæ) | | | Acarina * |
| | | Chrysomelidæ | | | *Leptodora* ** |
| | | Parnidæ (larvæ) | | | |

* Names with one star indicate food value for food and game fish, with two stars indicate that the group of animals is of special value as fish food.

The bottom animals may also be divided into producers, those that live on detritus and plants, and the consumers or those that are carnivorous and feed upon the producers. Some of the latter may be both producers and consumers if they vary their carnivorous diet with detritus or plants, as does the pond snail *Lymnæa* for example. In the table it will be noted that *the great majority of the animals represented are producers or herbivores and detritus eaters.* In Lower South Bay these animals feed largely on filamentous algæ, their bodies often assuming the peculiar pea green color of the algæ. To what extent the carnivorous animals or consumers affect the numbers and the production of the other animals is not known, but that it must be considerable is evident. The animals of herbivorous and detritus feeding habits, on the basis of the number of individuals given in Table No. 38, number about 7,743 million. Those of carnivorous habits number about 23 million. *The herbivorous and detritus feeding animals therefore outnumber the carnivorous feeding animals about 337 to one.*

In the discussion of the food relations of fish three major divisions of the subject should really be considered. First, the ultimate, or primitive food material, which comprises the chemical elements and compounds such as nitrogen, carbonic acid, phosphoric acid, calcium carbonate, silica, etc., chemicals which are taken up by plant activities (which are synthetic) and converted into the proteids, carbohydrates, and oils of the plant tissues. The plants form the second division standing between the chemical compounds which are directly useless to animal life and converting them into digestible material which the animals are able to use. The animals form the third division, and convert the plant tissue into animal proteids, fats, and carbohydrates. These animals then form the food of a majority of fish. It will be seen, therefore, that a study of the food question includes broadly the physical medium surrounding the plants, the plants themselves, and the animals using these plants as food. Johnstone's ('08, pp. 189–190) comparison of the "crop of the sea" (plankton) with the crop of the land (hay, grain, potatoes, etc.) and of fish, mussels, lobsters, etc., with the ox, sheep, and pig is very suggestive and interesting in this connection. When compared in terms of the percentages of carbohydrates, fats, and proteids, the two classes of foods (of the sea and of the land) do not differ greatly in composition.

## Annual Production of Invertebrates

A large percentage of the invertebrate animals in Lower South Bay are annuals, completing their life cycles in one year. Such for example are the majority of the insects. In some animals, as some of the small Cladocera (Needham, '16, p. 186) there are many generations in a season, each generation living but a comparatively short time. In these animals the birth rate is very high, some insects, as *Hexagenia* (Morgan, '13, p. 377) require two years to attain maturity. In the Copepods, Amphipods and Isopods there are also several generations (four in the Amphipods, Embody, '12, pp. 25–29). Many mollusks, however, live two or more years (the larger mussels live for a longer period). All mollusks lay a large number of eggs and in summer the young and immature individuals greatly outnumber the mature individuals. It is safe to assume, perhaps, as Petersen has done for the Danish marine waters ('11, p. 68) that the bottom fauna reproduces its own mass each year. Some fresh-water groups may do better than this and may be increasing in annual numbers. Aquatic animal life is probably more abundant during the spring and summer months than at other times of the year. Beginning in the early spring the over-wintering individuals emerge (or the over-wintering eggs hatch) lay their eggs and die. The number of living animals increases as one generation succeeds another, and reaches maturity during the summer and declines toward the fall and winter. It is possible that most fish find less food during the winter and this is the reason they are easily caught through the ice. The amount of food in a region will, therefore, vary with the time of year, and can not be expected to be the same at all times, either numerically or in kind. A group of animals may be abundant in July and not available in October or November. Petersen ('11, p. 4) states that he found the marine bottom fauna of the Kattegat and Baltic Sea to remain relatively unchanged for a period of twenty years. This should be borne in mind when the time comes to compare quantitative data covering several years in the investigation of lakes.

## Daily Consumption of Food by Fish

These quantitative investigations naturally lead to certain questions, such as, How much food does a fish consume in 24 hours? How many fish will a body of water like Lower South Bay sustain, with the quantity of fish food present indicated by the data presented in the previous pages? These questions are complicated by the fact that some fish eat vegetable matter and detritus almost entirely, while others include this material as only a part of their diet and there are many other factors, as season, age, etc. The average percentages of different classes of food eaten by our fresh water fish are shown below (Baker, '16, p. 154):

| | | |
|---|---|---|
| Insect | 40 | percent |
| Crustacean | 14 | " |
| Molluscan | 6 | " |
| Detritus and plants | 20 | " |
| Fish | 20 | " |
| Total | 100 | " |

It will be seen that but 60 percent of the food consists of the invertebrates under consideration in this report, and 20 percent more includes the detritus and plants or about 80 percent of the food of our fish.

The difficulty of ascertaining in a satisfactory manner the amount of food eaten by a fish in a given length of time (as in 24 hours) is obvious. Petersen realized this difficulty and experimented with the marine fish known as Plaice (*Pleuronectes platessa* Linn.) to find the amount of food eaten in 24 hours upon which to form a basis for calculations relating to the total amount of food available in Danish marine waters. For this purpose he caught numbers of fish at different times of the day to see if there was a difference in the quantity of food by night or by day. He found that in the early morning most of the digestive tracts were empty, but at 10 o'clock A. M. most tracts were filled. Fish caught in the afternoon and evening until 7 P. M. were also filled with food. From these facts Petersen concluded that the digestive tract was emptied once in the course of 24 hours ('11, pp. 63–66). Petersen's table (No. 53) is reproduced below:

TABLE NO. 53. FOOD OF PLAICE EATEN IN 24 HOURS

| Plaice from Glyngor 1910 | 22 Aug. 25 indiv. 10 A. M. | 23 Aug. 25 indiv 4–5 A.M. | 23 Aug. 20 indiv. 8 A. M. | 23 Aug. 12 indiv. 2. P. M. | 23 Aug. 40 indiv. 7 P. M. |
|---|---|---|---|---|---|
| Full stomachs and gut.............. | 20 | 1 | Very little in stomach and gut | 7 | 33 |
| Full stomachs and empty gut........ | 3 | 0 | | 0 | 1 |
| Empty stomachs and full gut...... | 1 | 0 | | 4 | 2 |
| Empty stomachs and empty gut.... | 1 | 14 | | 1 | 2 |
| A little in rectum.... | 0 | 10 | | 0 | 2 |

Blegvad has also investigated the question of the rate of digestion in some of the fish of European marine waters. He examined ('16, pp. 35–37) 290 young specimens of a common Goby (*Gobius ruthensparri* Euphrasen), a small marine fish abundant in the seas of northern Europe, at different hours of the day on six different days in August and September. He found that the food passed through the alimentary canal in about six hours. Most of these fish appeared to feed during the day time, the stomach being generally empty in the morning. In Table No. 54 the data upon which Blegvad based his conclusions are given.

The Plaice and Goby are marine fishes and, therefore, the experiments of Petersen and of Blegvad quoted above are mainly suggestive in the present connection. The difference between marine and fresh water fish as to their powers of digestion is well stated by Günther ('80, p. 122) in the following words: "On the whole, marine fishes are more voracious than those inhabiting fresh waters; and whilst the latter may survive total abstinence from food for weeks and months, the marine species succumb to hunger within a few days."

TABLE NO. 54. STOMACH EXAMINATIONS OF GOBY

| Hour | Stomach and intestine full | Empty stomach, full intestine | Stomach and intestine empty | Number of fish examined |
|---|---|---|---|---|
| 10 p. m. | 42 | 10 | 3 | 45 |
| 4 a. m. | 4 | 11 | 65 | 80 |
| 9 a. m. | 22 | 3 | ........ | 25 |
| 12 noon | 21 | 4 | ........ | 25 |
| 5 p. m. | 23 | 2 | ........ | 25 |
| 5 p. m. | 10 | ........ | ........ | 10 |
| 9:30 p. m. | 16 | ........ | 4 | 20 |
| 4 a. m. | ........ | 5* | 25 | 30 |
| 8 30 a. m. | 30† | ........ | ........ | 30 |

*A small amount of food in the intestine. †3 specimens had a small amount of food in the stomach, and empty intestine.

Our fresh-water fish vary greatly in their food habits and a considerable amount of investigation will be necessary before enough data are available upon which to base safe conclusions as to their rate of digestion and on the amount of food eaten by them.

Professor T. L. Hankinson has given the matter some consideration and the writer has consulted him freely. In the course of my correspondence with him he wrote: "I have no doubt that species and probably individuals vary greatly as to the frequency of taking food, and the rate of digestion would depend, as you know, on the kind of food and the vitality of the fish. Some forms are almost never found with empty digestive canals except at spawning time. This appears to be a period of fasting for fish, judging from food studies I have made, which are insufficient for any definite conclusion here. These are omnivorous or herbivorous fish. Fish that are strictly predators often have empty canals. This we would expect on account of the greater difficulty of getting food. I have no data on the frequency with which a fish fills its digestive canal or the amount it eats in a day. I doubt if any rule applying to fish generally can be found. Some fish like perch and some catfish, at least, appear to feed at all times of the year, and others like sunfish appear to take little food in the winter."

Experiments on the rate of digestion in fish and other cold-blooded vertebrate animals (*cf.* Riddle, '09, pp. 450–457) show that in fish (*Amiatus calvus* Linn.) the rate of digestion is highest, and in turtles (*Emydoidea*) digestion is the lowest. Temperature is shown to modify the rate of digestion in a marked degree. In *Amiatus* only a trace of digestion took place during 168 hours at a temperature of 2.5 C., 36.5 F. (November) while at a temperature of 29.8 C., 85.6 F. (April) a considerable amount of food was digested in 48 hours (p. 450). The influence of season, which is mainly the influence of temperature, is shown to be marked, the digestive powers being reduced by about one-third between November and March. Riddle states ('09, p. 454): "Midwinter to March is the period when digestion capacities are at the lowest point; while midsummer (July) is the season most favorable to digestion. It thus appears that the period of low digestion power falls within the fasting period of these animals, and the maximum of digestion power is attained during those months when a maximum of feeding is the rule." Fish are able to modify the effect of temperature to some extent in the winter by migrating from shallow cool waters to deeper warmer water, but this probably does not affect the rate of digestion to a large degree.

During the 1917 field season (August to October) many fish were caught in a trap net for the purpose of making studies relative to their infection by parasite worms, and incidentally a number of these fish were examined as to the food contents of their digestive organs. The trap net was emptied after intervals of 24, 48 and 72 hours. Upwards of seventy specimens of fish were examined and some very interesting data was obtained bearing in part on the length of time that food remains in the stomach. In Table No. 55 observations on 72 fish, of 12 species, are listed and the condition of the stomachs indicated. Of course, there was no way of knowing when the fish entered the trap, or just how long they were in it. Some of them undoubtedly had been caught not more than 24 hours but the data obtained *suggest* that this percentage of fish with food in the stomach decreases markedly with the greater time interval. Table No. 56 shows, for example, that of the 24 hour fish, 50 percent had food, the 48 hour fish had 12.9 percent with food, and that the 72 hour fish were without food. All were fully mature fish. The intestines of all fish contained some partly digested (macerated) matter which also decreased in amount and degree of digestion as the number of hours increased.

TABLE No. 55. FOOD IN FISH CAUGHT IN TRAP NET

| Fish* | Net set Hours | Fish examined | Fish with food | Fish without food |
|---|---|---|---|---|
| Common Bullhead | 24 | 4 | 2 | 2 |
| Common Bullhead | 48 | 15 | 2 | 13 |
| Yellow Bullhead | 48 | 4 | 0 | 4 |
| Yellow Perch | 48 | 7 | 1 | 6 |
| Rock Bass | 24 | 2 | 2 | 0 |
| S. M. Black Bass | 48 | 1 | 1 | 0 |
| S. M. Black Bass | 72 | 3 | 0 | 3 |
| L. M. Black Bass | 48 | 1 | 0 | 1 |
| Pumpkinseed | 72 | 5 | 0 | 5 |
| Bluegill | 48 | 4 | 0 | 4 |
| Calico Bass | 24 | 1 | 1 | 0 |
| Calico Bass | 48 | 4 | 1 | 3 |
| Carp | 24 | 3 | 0 | 3 |
| Chain Pickerel | 16 | 1 | 1 | 0 |
| Chain Pickerel | 24 | 1 | 0 | 1 |
| Chain Pickerel | 48 | 2 | 0 | 2 |
| Pike Perch | 24 | 1 | 1 | 0 |
| Pike Perch | 48 | 9 | 1 | 8 |
| Pike Perch | 72 | 3 | 0 | 3 |
| Totals | ........ | 71 | 13 | 58 |

*See page 220 for scientific names of fish.

Table No. 56. Comparison of Food with Hours

| Hours | Specimens examined | Specimens with food | Specimens without food | Per cent of food | |
|---|---|---|---|---|---|
| | | | | With | Without |
| 16 | 1 | 1 | 0 | 100 | 0 |
| 24 | 12 | 6 | 6 | 50 | 50 |
| 48 | 47 | 6 | 41 | 12.9 | 87.1 |
| 72 | 11 | 0 | 11 | 0 | 100 |
| Totals | 71 | 13 | 58 | 18 | 82 |

While this data is not conclusive, it adds weight to the belief that digestion is measurably rapid in fresh-water fish, at least in summer, and that it is possible that the stomach may be emptied in 24 hours and the intestine in about 48 hours. Feeding experiments on a large scale would be of great interest and value in this connection.

As stated previously, little direct data are at hand to indicate the amount of food eaten by the fish of our inland waters, and none has been seen by the writer bearing on the amount eaten in a definite time. In a previous bulletin (Baker, '16, pp. 165–204) some facts are given as to the number of individual animals found in the stomach at one time, which may bear on this subject, though it is very imperfect and very unsatisfactory. It may be assumed that the full stomachs and gut of these fish represent the maximum amount of food taken in a certain period of time, in this case arbitrarily placed at 24 hours. As the amount of food present varied in the specimens examined, the general average may be the true condition. Fish for food studies should be freshly caught to obtain the best results, and individuals caught in fyke nets long left in water are usually not reliable for certain studies because digestion has made progress to such an extent that much of the food is unrecognizable or the digestive canal may be entirely empty. The data from these individuals with fairly well filled digestive tracts is presented below.

Common Sucker (*Catostomus commersonii*). Adult, 390 mm. long (Baker '16, p. 165).

| | | |
|---|---|---|
| Mollusca: | | |
| *Valvata tricarinata*, young and adult....... | 17 | |
| *Galba catascopium*, young................. | 1 | |
| *Pisidium henslowanum* .................... | 25 | |
| *Sphærium vermontanum*, young........... | 1 | |
| | — | 44 |
| Insecta: | | |
| *Hexagenia* nymph ....................... | 4 | |
| Chironomid larvæ ....................... | 420 | |
| | — | 424 |
| Total number of specimens............... | | 468 |

Pumpkinseed Sunfish (*Eupomotis gibbosus*). Adult, 140 mm. long (p. 186).

| | | | |
|---|---|---|---|
| In stomach: | | | |
| Mollusca: | | | |
| *Bythinia tentaculata*, young.......... | 3 | | |
| *Planorbis antrosus*, young.......... | 3 | | |
| | — | 6 | |
| Insecta: | | | |
| *Helicopsyche* ......................... | | 1 | |
| | | — | 7 |
| In intestine (or gut): | | | |
| Mollusca: | | | |
| *Bythinia tentaculata*, young.......... | 6 | | |
| *Amnicola lustrica*, adult............. | 3 | | |
| *Valvata tricarinata*, adult............ | 5 | | |
| *Valvata bicarinata normalis*, adult... | 1 | | |
| *Planorbis exacuous*, half grown...... | 3 | | |
| *Planorbis antrosus*, young........... | 2 | | |
| *Sphærium vermontanum*, young...... | 1 | | |
| *Pisidium* species, adult.............. | 1 | | |
| | — | 22 | |
| Crustacea: | | | |
| *Hyalella knickerbockeri*, adult........... | | 2 | |
| | | — | 24 |
| Total number of specimens.............. | | | 31 |

Pumpkinseed Sunfish (*Eupomotis gibbosus*). Adult and young (pp. 202, 205).

| Size of fish | 68 mm. | 70 mm. | 150 mm. | Adult | Total |
|---|---|---|---|---|---|
| Mollusca: | | | | | |
| *Physa heterostropha*. | ...... | ....... | ....... | | |
| *Galba desidiosa* | | | | 34 | |
| (= *obrussa*) young | ...... | ....... | ....... | | |
| Total mollusks.. | ...... | ....... | ....... | ....... | 34 |
| Insecta: | | | | | |
| Chironomid larvæ... | 44 | 14 | 150 | 12 | 220 |
| Chironomid pupæ... | 10 | 6 | 9 | ....... | 25 |
| *Chauliodes* larva.... | ...... | ....... | ....... | 1 | 1 |
| Total associated animals....... | ...... | ....... | ....... | ....... | 246 |
| Total number of specimens....... | 54 | 20 | 159 | 13 | 280 |

Chain Pickerel (*Esox reticulatus*). Adult and young (pp. 201–202).

| Size of fish | 117 mm. | 117 mm. | 119 mm. | 270 mm. | Total food specimens |
|---|---|---|---|---|---|
| Adult midge .......... | 1 | ....... | ....... | ....... | 1 |
| Chironomid larvæ ..... | 41 | 59 | 8 | 257 | 365 |
| Chironomid pupæ ...... | 6 | 10 | ....... | 8 | 24 |
| *Enallagma* nymph ..... | 1 | 2 | 4 | ....... | 7 |
| *Callibætis* nymph ...... | 7 | 2 | 3 | ....... | 12 |
| *Cænis* nymph .......... | 8 | ....... | ....... | ....... | 3 |
| Piece of fish........... | ...... | ....... | ....... | x | x |
| Total number of specimens ..... | 59 | 73 | 15 | 265 | 412 |

Tessellated Darter (*Boleosoma nigrum olmstedi*). 85 mm. (p. 196).

| Crustacea | |
|---|---|
| *Gammarus fasciatus* ........................... | 1 |
| *Hyalella knickerbockeri* ........................ | 2 |
| *Asellus* ........................................ | 15 |
| Total number of specimens.................. | 18 |

Ling or Lawyer (*Lota maculosa*). 420 mm. (p. 199).

| | |
|---|---|
| *Cambarus propinquus* ........................... | 7 |
| *Cambarus bartoni robustus*...................... | 1 |
| Total number of specimens.................. | 8 |

Brook Silversides (*Labidesthes sicculus*). Adult 51 mm. (p. 181).

| | |
|---|---|
| Adult midges | 17 |
| Water mites | 2 |
| *Bosmina longirostris* | 74 |
| Total number of specimens | 93 |

Upwards of 110 fish were examined for food; in 26 the digestive tracts were empty and in 84 there was more or less food in the stomach or digestive tract. In percentages this means 30.9 empty and 69.1 with food. Of the 110 individuals examined but 13 or 11.8 percent had the stomach and digestive tract full enough to give satisfactory data, and the information furnished by the Oneida Lake fish is therefore meagre and unsatisfactory on this particular point. It is all there is at hand, however. The value and urgency of an accurate and exhaustive study of the food habits of our fish is apparent. The 13 fish listed on the previous pages show a total consumption of 106 mollusks and 1,258 associated animals, or an average of 8.1 mollusks and 96.7 associated animals per fish. There was a small amount of macerated matter besides broken shells, caddis-fly cases, etc., in some of the fish, averaging perhaps 10 percent of the amount present, which should be added to the larger amount, raising the average quantity per fish to 8.9 mollusks, and 106.4 associated animals, a total of 115.4 animals per fish.

The young fish and those adult fish that feed almost exclusively on plankton organisms are not here included, no detailed work having been done on the plankton of the lake. Reighard (15, p. 224) examined the digestive tract of a young Common Sucker (*Catostomus commersonii*) upwards of two inches long, and estimated that there were 2,400 *Chydorus* and 48 copepods present, indicating that young fish are large consumers of the plankton. Juday ('07, p. 142) examined the stomach of an adult Tahoe Trout (*Salmo henshawi* Gill and Jordan) 15 inches long and estimated that it contained 1,739 specimens of *Daphnia* (about two-thirds *Daphnia pulex* and the rest *Daphnia hyalina*) showing that some adult fish are also large consumers of plankton animals.

Some years ago, Forbes ('88, p. 5; '03, p. 36) examined the stomach of two Pike Perch (*Stizostedion vitreum*) from Peoria Lake, Ill., and found 10 specimens of Gizzard Shad (*Dorosoma cepedianum*) in one Pike Perch and 7 specimens in another. These fish were from 3 to 4 inches long. Forbes estimated that a Pike Perch could not thrive on less than three full meals a week averaging 5 small fish for a meal. Assuming that the Pike Perch feeds for 40 weeks of the year, Forbes estimated, on the above basis, that the Pike Perch eats 600 Gizzard Shad in the course of a year. This would mean that 100 Pike Perch, in a year's time, would consume 60,000 Gizzard Shad. The data upon which this estimate is based is quite insufficient but indicates in a measure the number of small fish that are necessary to support a large community of a predacious fish like the Pike Perch.

During the 1917 field work on Oneida Lake a number of Pike Perch were collected in trap nets of which 3 out of 15 specimens examined contained fish in the stomach. One (20 inches long) had a Pumpkinseed 4 inches long (No. 1252); another (13 inches long) had 4 small fish 1½ inches long, partly macerated; and a third (20 inches long) had one fish nearly 4 inches long, partly macerated and unidentifiable (No. 1229). From these examinations it would appear that these Oneida Lake Pike Perch did not use as many small fish for a meal as did Illinois specimens. As Forbes does not give the size of the Pike Perch examined it is possible that they might have been larger individuals than the Oneida Lake specimens examined. On the basis of the average food of the Oneida Lake Pike Perch examined, 2 small fish per stomach, using the feeding time indicated by Forbes, 40 weeks, and three meals a week of 2 fish each, we calculate that a single Pike Perch, of the average size of 17 inches long, will consume 240 small fish in a year. On this basis 100 Pike Perch will eat 24,000 small fish each year. Forbes' estimate of 6,000 food fish per year 100 Pike Perch will consume 60,000 small fish in the course of a year. On the basis of Riddle's ('09, p. 450) conclusion that the digestive powers are reduced one-third between November and March, these figures would be

31,200 per year for Oneida Lake Pike Perch and 71,500 for Illinois Pike Perch. While these figures are at most rough estimates, they nevertheless show that the number of small fish in the lake must be large not only to feed the Pike Perch, but also the other predatory species, as the Small-mouthed Black Bass, Pickerel, and Common Pike. It also follows that a large invertebrate animal population is necessary to provide food for these small fish as well as an abundance of vegetation for the invertebrate animals to feed upon. These needs have been shown to be met by the abundance of the plants and bottom animals of Lower South Bay and vicinity.

## Estimated Fish Population

It is realized that the data upon which the estimates of the amount of food eaten by fish are based are very fragmentary and imperfect, and the figures given below can be taken only as rough estimates. The data concerning the available supply of fish food, however, is believed to be accurate. It is information concerning the amount of the different kinds of food consumed in a given time by the fish that is lacking. The quantity of food taken in winter, spring, and fall as compared with summer should also be ascertained.

There are several factors to be considered in computing the number of fish that the bottom animals of Lower South Bay will support. One group of mollusks, the mussels (Unionidæ) should perhaps be excluded from the estimate of fish food because they are not at present known to be used by Oneida Lake fish. These mussels are computed to number 9,013,265 individuals or about .01 of one percent of the number of individual invertebrates of Lower South Bay. This percent is so small that this factor may be ignored. It is not possible at the present time to estimate the amount of invertebrate food eaten by other carnivorous vertebrate animals, such as frogs, turtles, and birds, but it is probable that the number of invertebrate animals eaten reduces the amount available for fish to a considerable extent. The amount of herbivorous and detritus eating invertebrates eaten by carnivorous invertebrates is probably not large enough to affect the total amount of the invertebrate fish food, because the carnivorous invertebrates amount to but .03 of one percent of the total number of invertebrate individuals living in Lower South Bay.

As the modifying factors referred to above are either of such a small percentage as to be practically negligible or are inadequately known, the object sought will be to ascertain simply the total number of fish that the invertebrate bottom animals of Lower South Bay will provide food for, based on the number of invertebrate animals computed to be living in this bay during the month of July.

The examination of the full stomachs and digestive tracts of 13 Oneida Lake fish indicated that each fish consumed on an average 115.4 invertebrate animals in a certain period, here arbitrarily placed at 24 hours (this does not include the food of the young fish nor of typical plankton eaters). This abundant food supply is probably available for but nine months of the year (March to November inclusive), and is probably reduced (by hibernation, or in egg stage) in amount during the winter months. To make a conservative estimate, as there is little information regarding the winter food of fish, it will be assumed that food is available in the same abundance as recorded during July for nine months of 275 days. This would indicate a total consumption per fish in one year of 31,735 individuals of the invertebrate fauna. If this is a fair average, then the Lower South Bay area of 1,164 acres would support 244,455 fish. It has been shown, however, that 20 percent of the food of fish consists of detritus and plants, and another 20 percent of small fish, and allowance should be made for this in calculating the number of fish the food indicated will sustain. These figures therefore indicate a total possible fish population of 407,425 in 1,164 acres or 350 fish per acre. The average applied to the whole of Oneida Lake indicates a total population (51,200 acres) of 18,270,000 fish. What relation these figures bear to the actual fish population of the lake is not known as no figures are available for comparison.

## List of Fish from Lower South Bay

That this rich food supply is made use of by the fish population of this region is evidenced by the following partial list of species inhabiting Lower South Bay and vicinity, furnished by Dr. C. C. Adams and Professor T. L. Hankinson. The fish were most abundant in shallow places usually where there was considerable vegetation and hence an abundance of food. It is also to be noted that there is an abundance of the smaller fish for such fish as the Pickerel, Pike, and Black Bass, and also a great quantity of invertebrate animals which serve as food for these smaller fish. In fact, the food problem seems to have been abundantly provided for by the amount and variety of the animals and plants in this region, and it is apparent that there is here a natural food supply for a very large number of our most valuable food and game fishes.

### LOWER SOUTH BAY

*Catostomus commersonii* (Lacépède). Common Sucker.
*Ameiurus natalis* (LeSueur). Yellow Bullhead.
*Ameiurus nebulosus* (LeSueur). Common Bullhead.
*Ambloplites rupestris* (Raf.). Rock Bass.
*Pomoxis sparoides* (Lacépède). Calico Bass.
*Eupomotis gibbosus* (Linn.). Pumpkinseed.
*Micropterus salmoides* Lacépède. Large-mouthed Black Bass.
*Micropterus dolomieu* Lacédède. Small-mouthed Black Bass.
*Perca flavescens* (Mitchell). Perch.
*Hybognathus nuchalis* Agassiz. Silvery Minnow.
*Pimephalus notatus* (Raf.). Blunt-nosed Minnow.
*Abramis chrysoleucas* (Mitchell). Golden Shiner.
*Notropis cayuga* Meek. Cayuga Minnow.
*Notropis hudsonius* (DeWitt Clinton). Spot-tailed Minnow.
*Notropis whipplii* (Girard). Silverfin Minnow.
*Notropis atherinoides* Raf. Emerald Minnow.
*Notropis rubrifrons* (Cope). Rosy-faced Minnow.
*Semotilus bullaris* (Raf.). Fallfish.

*Fundulus diaphanus* (LeSueur). Barred Killifish.
*Labidesthes sicculus* (Cope). Brook Silversides.
*Percina caprodes zebra* (Agassiz). Manitou Darter.
*Boleosoma nigrum olmstedi* (Storer). Tessellated Darter.
*Etheosoma iowae* (Jordan and Meek). Iowa Darter.

SHORT POINT BAY

*Catostomus commersonii* (Lacépède). Common Sucker.
*Ameiurus nebulosus* (LeSueur). Common Bullhead.
*Esox reticulatus* LeSueur. Chain Pickerel.
*Esox lucius* Linn. Common Pike.
*Ambloplites rupestris* (Raf.). Rock Bass.
*Eupomotis gibbosus* (Linn.). Pumpkinseed Sunfish.
*Micropterus salmoides* (Lacépède). Large-mouthed Black Bass.
*Perca flavescens* (Mitchell). Perch.
*Pimephales notatus* (Raf.). Blunt-nosed Minnow.
*Abramis chrysoleucas* (Mitchell). Golden Shiner.
*Notropis cayuga* Meek. Cayuga Minnow.
*Notropis hudsonius* (DeWitt Clinton). Spot-tailed Minnow.
*Notropis atherinoides* Raf. Emerald Minnow.
*Fundulus diaphanus* (LeSueur). Barred Killifish.
*Percina caprodes zebra* (Agassiz). Manitou Darter.

## SUMMARY AND CONCLUSIONS

In the previous pages we have attempted to ascertain the amount of animal life present on the bottom of Lower South Bay and vicinity. It was found that this bay contained several diverse habitats and that the animals and the vegetation showed a corresponding variation. A feature brought out in the investigations is the fact that *the greatest development of plant and animal life on the bottom is found within the 6-foot contour.* Of the 1,164 acres examined about 88 percent of the number of individual invertibrate animals were found within the 6-foot contour, and only 12 percent outside this area, or in round numbers *6,786 million individuals inside* this line, and *983 million beyond* this line. From the standpoint of area this means a population of almost seven billion individuals in 205 acres, within the 6-foot contour, and beyond this line a population of less than one billion individuals in 959 acres. Per acre, this also means that an average of 33 million individuals live in one acre in water 6 feet or less in depth, while but one million individuals per acre live in water deeper than 6 feet. The drop in density of population from the 6-foot area to the 6–12 foot area is striking, the population of the deeper area being but 11 percent of the shallower area. Beyond the 6–12 foot area the decrease in number of individuals is much less marked, amounting to 59 percent of the population of the 6–12 foot area. When we remember that fish are more abundant within the 6-foot contour, where the majority of young fish live and most adult fish breed, the significance of this richness of bottom life in the shallow water is at once realized, and indicates that this is the most important depth for the culture of fish.

Of the different kinds of bottom areas examined in Lower South Bay, it was found that the sand bottom was the richest in animal life and the boulder bottom the poorest. In percentage this may be expressed as follows, the sand bottom being valued at 100 percent: sandy clay 87 percent, clay 66 percent, gravel 57 percent, mud 42 percent, and boulder 46 percent. In the areas examined in the vicinity of Lower South Bay the sand bottom in shallow water was the richest in individuals, averaging about 110 million per acre while the boulder shore was the poorest, averaging about 4 million to the acre, or less than 4 percent of the population of the sand areas.

A striking feature of the plant life was the presence of large quantities of filamentous algæ which covered the bottom in many places like a blanket, which greatly modifies the character of the bottom. It seems probable that the great wealth of life in Lower South Bay is largely due to the presence of this plant which provides a rich food supply for the invertebrate animals. The presence of such a quantity of algæ is believed to be the reason that the higher plants were not made of greater use by the herbivorous animals.

The great predominance of animals of herbivorous and detritus feeding habits over those of carnivorous habits is clearly shown, the former amounting to about 7,743 million individuals and the latter to about 23 million individuals or about .29 of one percent. This fact is important when it is recalled that the *herbivorous animals are producers* and the *carnivorous animals are consumers of fish food.*

Another feature of interest brought out by the investigation is the predominance of mollusks in individuals over any other group of animals, the mollusks, in fact, surpassing in number all groups of associated animals combined. In figures, this means 4,704 million mollusks, and 3,062 million associated animals. The mollusks are therefore 30 percent greater in number of individuals. This plurality of mollusks over associated animals is indicated by Blegvad ('16, pp. 22, 23) for marine quantitative studies. It was also found that the mollusks were subject to a limited migration, the young of some species of *Galba, Acella, Physa,* and *Planorbis* living in water from 6–14 feet deep, among algæ, when young, and migrating to the shore in shallow water when adult or nearly adult. It was likewise observed that a large percentage of mollusks were young or immature at this time of year (July).

An attempt has been made to determine the number of fish that this rich store of invertebrate animal life will feed. The examination of the digestive tracts of fish caught in trap nets, examined after intervals of 24, 48, and 72 hours indicate that digestion is rather rapid in summer and that it is possible that the stomach may be emptied in 24 hours and the intestine in 48 hours. The percentage of fish with empty stomachs increased rapidly with the time interval of emptying the net, 50 percent had full stomachs in the 24 hour interval, 12.9 percent in the 48 hour interval, and all had empty stomachs in the 72 hour interval. This data is not conclusive but adds weight to the belief that in the summer months the stomach may be emptied in about 24 hours. It is estimated that the invertebrate animals on the bottom of the 1,164 acres examined would feed 407,425 fish for one year.

It is important to consider some of the conclusions of the investigators of marine life, and although the life of the sea and of the inland waters are not strictly comparable, there is yet much in the final analysis of the results that is common to both. Johnstone ('08, p. 178) wisely warns against interpreting the phrase "census of the sea" too literally. Census figures that are based on some quantitative plankton investigations and all commercial fishery statistics and fishing experiments Johnstone criticizes as but very rough approximations to the truth. They have but relative value. With the methods used by Petersen a census, however, becomes much more accurate for sea areas and in the case of fresh-water areas may be made fairly accurate, so as to give a true picture of the life on the bottom, particularly in shallow waters.

Johnstone ('08, p. 179) further says: "But when we have obtained these approximate figures for the population of the sea it is not enough, for such populations are continually changing. Organisms die and fall to the sea bottom and decompose, or are devoured by their enemies or are captured by man. Birth-rates in the sea vary with each kind of organism and change with the season, and the rates of growth undergo corresponding fluctuations. Death-rates, too, change with the season, and with changes in the density of inimical organisms. Not only must we attempt to estimate the density of the population in the sea at a given time, but we must also try to find out what mass of living substance is periodically generated."

In the marine quantitative studies effort has been mainly directed toward ascertaining the quantity of utilizable production. Thus the number of fish in the North Sea and in other fishing districts has been estimated from the size of the catch landed at the fishing ports, the assumption being that a fourth of the adult fishes are caught yearly. This is obviously, as stated by Johnstone (pp. 180–186), too low, as it includes only the marketable individuals and species. It is the total production of life in a body of water (either in the sea or in the inland waters) that is now sought by the modern economic investigator. We wish to know what may be the total mass of life generated in a year. Johnstone ('08, p. 187) provides a simile which is very apt and which is here repeated. "At the beginning of the year a certain mass of life is present, and the end of the year much the same quantity is present. But in the meantime all organisms have been reproducing and growing. The mass of life at the beginning of the year is the capital; the mass generated during the year by the reproduction and growth of the capital is the interest. At the end of the year the capital remains the same; the interest has been eaten up, or otherwise destroyed. What is the rate of interest?"

Johnstone (p. 187) adds a table in which his idea of the knowledge necessary for finding this rate of interest is indicated. These are arranged under five heads, as follows:

1. Rate of reproduction of each species of organism under different conditions (temperature, weather, etc.).
2. Rate of growth of individuals of each species (and under different conditions).
3. Average duration of life of the individuals of each species.
4. Duration of reproductive activity in the life history of each species.
5. Amount of natural destruction due to enemies.

If the specifications indicated in this table could be met we should have a body of data which would enable us to understand very thoroughly the needs of our food and game fish, and this data would aid greatly in solving many of the problems of fish culture.

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# APPENDIX

CONTENTS



All type specimens are in the collection of the Department of Forest Zoology of The New York State College of Forestry, at Syracuse University, and will be deposited in the United States National Museum, Washington, D. C.

Date of publication, July 17, 1918.

# A NEW SPECIES AND A NEW VARIETY OF ALGÆ FROM ONEIDA LAKE

By Dr. E. N. Transeau

Ohio State University, Columbus, Ohio

**Mougeotia americana** nov. sp. Plate A.

Cellulis vegetativis 4 microns x 40–120 microns; cellulis conjugatis geniculatis; zygosporis inter 4 cellulis sitis, irregulariter quadratus, cum lateribus vel concavis vel tumidis, angulis productis, 13–24 microns x 18–32 microns; mesosporio hyalino lævo; aplanosporis oblique ellipticis, polis truncatis, 10–14 microns x 20–20 microns.

Vegetative cells 4 microns x 40–120 microns; conjugating cells slightly or strongly geniculate; zygospore adjoined by four cells, irregularly quadrate with concave or convex sides, the space between the zygospore and the sporangium walls being filled with (cellulose), 13–24 microns x 18–32 microns, wall smooth, transparent, aplanospores obliquely elliptical, ends truncate at the middle of very long genuflexed vegetative cells, 10–14 microns x 20–26 microns.

Field No. 929, southwest side of Lower South Bay, Oneida Lake, N. Y. Clay bottom, water 4 feet deep. July 20, 1916. Collector F. C. Baker. Plate A. *Mougeotia americana* nov. sp.

**Œdogonium crassum longum** nov. var.

Var. oogoniis oosporisque comparate ad cellulas vegetativas longioribus; ceterum ut in type.

Variety with elongated oogonia and oospores; otherwise similar to the type.

| | | | | | |
|---|---|---|---|---|---|
| Diam. veg. cells, female plant | 40–52 | microns, | length | 100–240 | microns |
| Diam. " " male plant | 36–44 | " | " | 100–180 | " |
| Diam. oogonia | 68–84 | " | " | 120–180 | " |
| Diam. oospore | 66–80 | " | " | 100–125 | " |
| Diam. antheridia | 34–40 | " | " | 8–14 | " |

Field No. 816, third bay, north side Short Point Bay, Oneida Lake, N. Y. Black mud bottom, water 3½ feet deep. July 17, 1916. Collector F. C. Baker.

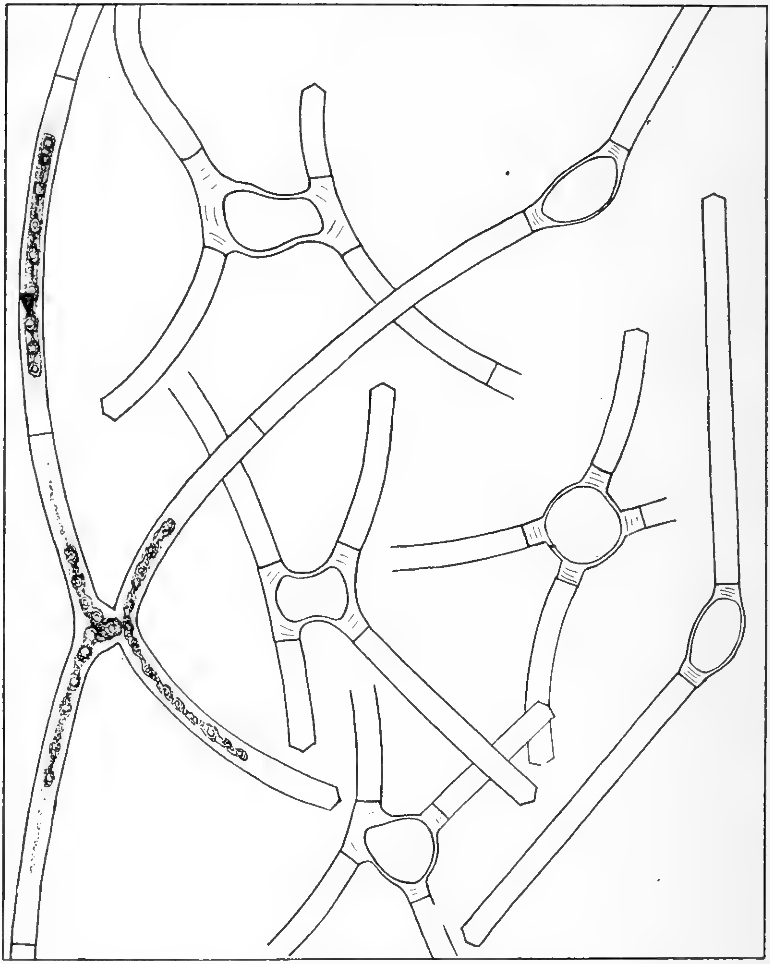


Plate A. *Mougeotia americana* Transeau, new species.

# A NEW SPECIES OF SPONGILLA FROM ONEIDA LAKE, NEW YORK*

By Professor FRANK SMITH

University of Illinois, Urbana, Illinois

A small collection of sponges from Oneida Lake, N. Y., was made in the summer of 1917 in connection with certain investigations of the Department of Forest Zoology of The New York State College of Forestry at Syracuse University and was submitted to the writer for identification. It was found to contain various colonies of *Spongilla fragilis* Leidy, very young colonies of *Spongilla lacustris,* Auct., one colony of *Carterius tubisperma* Mills, and specimens of a new species of *Spongilla* which is described in this paper. The writer takes this opportunity to express his appreciation of the kindness of Mr. Frank C. Baker to whom he is indebted for the privilege of studying the material.

**Spongilla heterosclerifera** nov. sp., Plate B.

*Sponge* forming a thin layer, without branches, rather loose in structure and friable; color green or pale, depending on the exposure to light. Colonies of a diameter of 2 cm. or more have abundant gemmules.

*Skeleton* of well defined radiating fibres, which in cross section usually include 4–6 spicules; irregular and poorly defined transverse fibres; comparatively little spongin present.

*Spicules.* Skeleton spicules are more commonly fairly stout, slightly curved, sharp pointed, and rather closely crowded with small spines except on the smooth terminal parts which are of variable extent, but each of which is usually less than one-sixth of the entire length of the spicule. There are no true flesh or dermal spicules. Gemmule spicules of various types ranging between stout, cylindrical, strongly spined amphistrongyli; long, slender amphistrongyli; and slender,

*Contribution from the Zoological Laboratory, University of Illinois. No. 102.

smooth or sparsely spined amphioxi. The first mentioned cover the foraminal side of the gemmules and the others are associated with the other side which is next to the substratum.

*Gemmules* are abundant and form a pavement layer on the substratum and are surrounded and bound together into a firm crust by a cellular pneumatic layer which is closely crowded with spicules of which the majority are of the short, stout amphistrongylous type.

The material available consists of a few dry colonies borne on the surface of stones.

Holotype. Cat. No. 9190, U. S. Nat. Mus. Paratypes in the collection of The New York State College of Forestry, No. —, and in that of the writer.

At a first glance one might assume that the colonies belong to *S. fragilis,* but an examination of the spicules under the microscope at once shows the wide difference between the two species, since in *S. fragilis* the skeleton spicules are smooth while in the new form they are profusely covered with small spines except near the ends (fig. 1). Another notable difference is found in the striking difference between the gemmule spicules (fig. 2) on the foraminal surface of the gemmules, and the more slender, elongate, sparsely distributed ones on the surface next to the substratum.

Figures 3 and 4 illustrate some of the more usual forms among the latter and one can find various sorts of intergrades.

In *S. fragilis* the spicules in the thin layer between the pavement layer gemmule aggregates and the substratum are somewhat more sparsely distributed than on the opposite side of the gemmules; the spinous amphistrongyli are in some specimens somewhat more elongate and slender, and there are sometimes slender amphioxi which are considerably smaller than the skeleton spicules; but there are few or no such spicules as are represented in figure 4; and in most specimens of *S. fragilis* examined by the writer, there is but slight differentiation between the spicules from the different surfaces of the gemmule layers.

In *S. heteroscleriferа* the length of the skeleton spicules is .22–.27 mm. with an average of about .25 mm. and the diameter at the middle is .015–.02 mm. with the latter dimension the more common. The length of the gemmule amphistrongyli of the more abundant type is .04–.065 mm. and the diameter .006–.007 mm. The length of gemmule amphistrongyli from the substratum layer is .07–.10 mm. and the diameter .004–.005 mm. The length of the amphioxi from the same layer is .15–.17 mm. and the diameter at the middle .005 mm.

The gemmules are somewhat flattened and the chitinous layer which is of moderate thickness is prolonged into a foraminal tubule which reaches slightly above the pneumatic crust (fig. 6). The cellular structure of the pneumatic layer (fig. 5) is less obvious than in *S. fragilis,* in part because of the transparency of the walls of the spaces, and in part because of the densely crowded mass of spicules with which it is charged. The diameter of the gemmules in the plane of the substratum shows considerable variability but averages about .5 mm., and the height in the axis of the foramen and perpendicular to the substratum is half or two-thirds as much. Figures 7 and 8 show something of the marked difference between the two surfaces af a cleared fragment of a gemmule layer. The actual difference is still greater since figure 7 represents only a superficial layer of what is actually a thick crust of spicules.

Whether or not older colonies may form groups of gemmules in the sponge mass apart from the substratum, as do those of *S. fragilis,* is not yet known. Colonies of the latter species in the same collection have only the pavement layer and are apparently rather young colonies, as are presumably those of the new form.

There are approximately 50 known species of *Spongilla,* and of these the majority have smooth skeleton spicules. Very few indeed combine the characters of spinous skeleton spicules and a pavement layer of gemmules, and of these the new species is the only one known from North America.

## PLATE B

### Explanation of Figures

All drawings were made with the aid of the camera from type material of *Spongilla heterosclerifera* nov. sp. Figures 1–5 x 220, 6–8 x 55.

Fig. 1. Skeleton spicules.

Fig. 2. Gemmule amphistrongyli from the foraminal side of the gemmule layer.

Fig. 3. Gemmule amphistrongyli from the substratum side of the gemmule layer.

Fig. 4. Gemmule amphioxi from the substratum side of the gemmule layer.

Fig. 5. Cellular pneumatic layer near the substratum with included spicules.

Fig. 6. Cross section of gemmule layer showing spicules of only the foraminal surface.

Fig. 7. Foraminal surface of gemmule layer showing only superficial spicules.

Fig. 8. Substratum surface of gemmule layer.

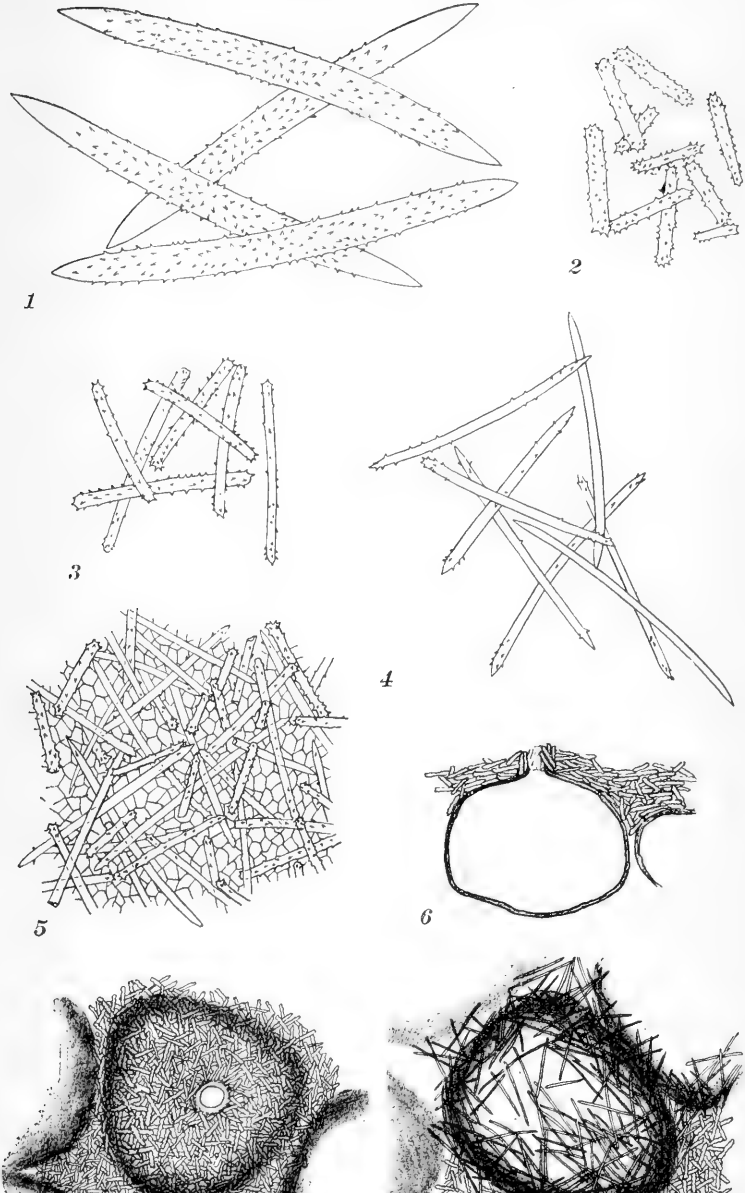



PLATE B. Figures of *Spongilla heterosclerifera* nov. sp.

# NEW SPECIES OF AMNICOLIDÆ FROM ONEIDA LAKE, NEW YORK

By Henry A. Pilsbry

Academy of Natural Sciences of Philadelphia, Philadelphia, Pa.

The New York State College of Forestry, under the direction of Professor Hugh P. Baker, is carrying on a biological survey of Oneida Lake and has issued an interesting bulletin upon the relations of mollusks to fish, by Frank C. Baker. Some Amnicolidæ obtained during this work, and subsequent to the preparation of the bulletin, were submitted to the writer. The collection proves to be of considerable interest, including some species not before noticed.

**Amnicola bakeriana** Pilsbry.

The shell is umbilicate, turrited-conic, thin whitish-corneous, somewhat translucent, with unevenly developed striation, distinct and close in places, weaker and sparse elsewhere. The summit is decidedly obtuse, as in *A. limosa,* the first whorl being nearly planorboid; subsequent whorls are evenly, strongly convex. The aperture is very shortly ovate, almost round, its length contained about 2½ times in that of the shell. Peristome thin, in contact with the preceding whorl for a short distance.

Length 4.3, diam. 2.7 mm.; 5 whorls (type)
Length 3.75, diam. 2.3, length of aperture 1.35 mm.; 4 2/3 whorls
Length 4.1, diam. 2.75, length of aperture 1.65 mm.; 4 2/3 whorls
[Cotypes, New York State College of Forestry, No. 1048c]
Oneida Lake; off Short Point in 8½ ft., mud bottom. Lower South Bay, in 18 ft., on mud bottom.

This species resembles *A. limosa* in the conspicuously obtuse apex, but differs by the more elevated, turrited spire and the smaller calibre of the whorls, hence smaller aperture. It is also a weaker shell, with more whorls in specimens of the same length.

There is also an abundant smaller form, resembling the typical form in texture, apex and shape of the whorls, varying in form, but relatively broader than the type. There are some intermediate examples, but as Mr. Baker considers it desirable to have a designation for this form, it may be called *A. bakeriana* form *nimia*. The type measures: length 3, diam. 2.5, length of aperture 1.4 mm.; 4 whorls. [Cotypes, New York State College of Forestry, No. 1048b.] Off Short Point in 8½ feet, mud bottom.

**Amnicola clarkei** Pilsbry.

The shell is narrowly umbilicate, conic, a little obtuse at the apex, corneous, nearly smooth. The whorls are very convex, separated by a deep suture, the last whorl tubular. The aperture is distinctly oblique, almost circular, the upper end rounded, but a trifle more narrowly so than the base. It projects but little beyond the preceding whorl laterally. The peristome is thin, continuous scarcely or barely in contact with the preceding whorl above.

Length 3.1, diam. 1.9, length aperture 1.1 mm.; 5 whorls (type)
Length 2.8, diam. 1.6, aperture 0.85 mm.
[Cotypes, New York State College of Forestry, No. 820d]

Operculum having the spiral rather large, the nucleus being above the lower third.

This little species resembles *Lyogyrus* by its tubular whorls of small calibre. The whorls are more convex and increase less rapidly than in *Amnicola walkeriana,* which is also less slender. *A. schrockingeri* Ffld. has less deeply convex whorls, and the apex is more acute. *A. bakeriana* is much larger, with a more obtuse apex.

Found in Short Point Bay, Oneida Lake, near shore, in 3 feet of water, bottom of sand with algæ; also in Lower South Bay, etc. Collected by Mr. F. C. Baker.

It is named for Dr. John M. Clark, the distinguished Director of the Museum of the State of New York.

**Amnicola oneida** Pilsbry.

The shell is typically more slender than *A. lustrica,* turrited-conic, narrowly umbilicate, corneous, minutely striate. The apex is slightly obtuse, but the first whorl projects visibly, as in *lustrica,* whorls very convex, parted by a deep suture. The aperture is ovate, small, its length contained more than three times in that of the shell, upper extremity narrowly rounded. The peristome is continuous, thin, very briefly in contact with the preceding whorl above.

Length 4, diam. 2, length of aperture 1.25 mm.; 6 whorls

Lower South Bay, Oneida Lake, N. Y., collected by F. C. Baker, 1916

[Cotypes, New York State College of Forestry, No. 985e]

Lower South Bay, west of steamboat landing, water 4 feet deep, sandy bottom covered with algæ.

This species is typically narrower than *A. lustrica* Pils., with a smaller aperture and shorter whorls, but it is chiefly distinguished by the more convex whorls (deeper suture) and the rounded instead of angular posterior end of the aperture. In *Paluderstrina nickliniana* the last whorl is much longer. Possibly it may be a subspecies of *lustrica,* yet it has so distinct an appearance that a special name seems desirable. There are also wide examples, which still differ from *lustrica* by the deeper suture and aperture.

Reprinted, with bracketed additions, from
"The Nautilus", Vol. 31, pp. 44–46, 1917.

## DESCRIPTION OF A NEW VARIETY OF FRESH-WATER MUSSEL FROM ONEIDA LAKE, N. Y.

By Frank C. Baker

The New York State College of Forestry, at Syracuse University, Syracuse, N. Y.

**Lampsilis radiata oneidensis** F. C. Baker (Baker '16, fig. 44, Nos. 1, 3, 4).

Shell elliptical in outline, rounded at both ends, somewhat compressed; dorsal margin slightly curved, ventral margin rounded, notably so in the male shell; female shell produced postbasally; surface usually roughened by growth lines, rarely smooth; epidermis olive-green, the posterior half usually black or brown, obscuring the markings; a few dark green rays of the radiata type are present on some shells; umbones prominent, inflated, but little elevated above the contour of the dorsal margin; umbonal slopes rounded; cardinal teeth of the left valve double, rather heavy, serrated, the anterior cardinal higher than the posterior and pyramidal in shape, the posterior cardinal rectangular, somewhat compressed; the pit at the base of the anterior cardinal teeth is deep and wide; there is a small narrow pit at the base of the anterior cardinal teeth; cardinal teeth of right valve two in number, triangular. the anterior small, compressed, the posterior large, elevated above the anterior, forming a truncated pyramid; the pit between the teeth is narrow and deep; the anterior cardinal of this valve is reduced to a mere remnant in some individuals; the ridge joining the cardinal and lateral teeth is heavy and bears one or more tubercles; lateral teeth as in *radiata;* anterior adductor muscle scar, posterior adductor muscle scar, and dorsal muscle scar more heavily impressed than in *radiata;* nacre bluish-white, slight irridescent.

| Length | Heighth | Breadth | Type |
|---|---|---|---|
| 56 | 36 | 21 mm. | No. 211 h, a single specimen. |
| 52 | 35 | 20 mm. | No. 211 i, from the type lot. |
| 52 | 37 | 20 mm. | No. 211 j, from the type lot. |

Cotypes in collection of The New York State College of Forestry at Syracuse University, the Academy of Natural Sciences of Philadelphia, and Dr. Bryant Walker, Detroit, Mich.

This race of *Lampsilis* is related to both *radiata* and *luteola* From the latter it differs in the more elliptical sometimes orbicular outline of the male shell, the olive green and brown epidermis and in the cardinal teeth which are heavier and broader, not so deeply serrated, and of different shape. From *radiata* it differs in its outline, in its epidermis, which is not as rough, and in the cardinal teeth, which are not as heavy, and are more elevated, triangular and pyramidal. The pits at the base of the cardinal teeth are deeper. The race is common in Oneida Lake on mud bottom in water from 8 to 18 feet deep.

Adapted from "The Nautilus", Vol. 30, pp. 74–75, 1916.

## A NEW MAYFLY, CÆNIS, FROM ONEIDA LAKE, NEW YORK

By Professor JAMES G. NEEDHAM

Cornell University, Ithaca, N. Y.

In the course of Mr. Frank C. Baker's collecting of aquatic insects from Oneida Lake, N. Y., several specimens of nymphs of a curious little mayfly, hitherto unknown to science, were discovered. This little nymph I mistook for a member of the similar in form and genus *Ephemerella,* it being, of the size of a number of species in that genus, and more than twice as large as any American species of the genus *Cænis* hitherto made known. Upon more careful examination, I find that it is *Cænis* and with conspicuous ocellar tubercles doubtless allied to the *Cænis harrisella* of Europe, the nymphs of which are figured by Eaton in the Transactions of the Linnean Society of London, second series, volume 3, plate 42.

I have encountered this American species but once before. A single specimen was collected by Professor T. L. Hankinson from the bed of Walnut Lake in Michigan on the 26th of May, 1907. In the report of the Geological Survey of Michigan, 1907, page 263, I made mere mention of it under the name "*Ephemerella* sp." as follows: "A single curious larva with prominent head tubercles was taken." This seems to be in America an inhabitant only of lakes, though its European counterpart above mentioned is not. The species is readily recognized by its remarkable head tubercles. It may be briefly characterized as follows:

**Cænis lacustris** sp. nov.

Length 5–6 mm., antennæ 1½ mm., caudal filaments 3 mm. additional. An elongate species of generally pale coloration, beautifully marked with brown. Head cuboidal with prominent eyes capping the anterolateral angles. Three conspicuous pyramidal horns arise from the three ocelli, each horn surmounting a conspicuous black pigment spot. Body slender, yet having three regions of enlargement, the prominent horned head, the swollen mesothorax, and the laterally expanded gill-bearing portion of the abdomen.

General coloration pale, head with a pair of oblique zigzag bands extending backward from the eyes to the middle of the occiput, prothorax wholly pale above. Mesothorax somewhat darker across front and rear ends, and with a pair of curved black pencilings upon the middle of the dorsum. Abdomen with basal black mid-dorsal triangles on the segments in front and at rear; the gill-bearing middle segments obscurely brownish. There is also a pale brownish transverse line on either side of each segment near the lateral margin toward the front, and there is a pair of black dashes upon the rear of segment 10 above. Caudal filaments wholly pale, but in the darkest of the specimens showing very faint rings. Legs slender, increasing in length posteriorly, pale in color with a single brown submedium band on each segment. Claws gently curved, very long and slender and attenuate to a very sharp point, about equal in length to one-half of the tarsus.

Gills on segments 1 to 6. On segment 1, a long, erect tapering, lash-like rudiment set obliquely upon a short pedicel. On 2, a pair of quadrate opercua, straight margined on the front and within, more rounded externally and at the rear, bearing an oblique ridge that runs from the basal external articulation inward; brownish in color, with paler margins and with a pale Y-spot upon the middle, opening forward, one arm of the Y lying upon the dorsal ridge. Gills on segments 3, 4, 5 and 6 thin and lamelliform with a wide border of forking filaments wider than the body of the gill, all these filaments forking unilaterally, the branches springing from the inner side of the filament and all lying in one plane. These true gills diminish in size posteriorly, that of the sixth segment being about half as large as that of the third.

The gill-bearing segments are broadly depressed and laterally expanded into huge lateral spines, which, from above, have the aspect of a segment of a circular saw. The lateral tooth on segment 2 is obtusely pointed, all the others very sharply pointed, highest on fourth and fifth and directed more strongly toward the rear of each succeeding segment. Segment 7, which lacks gills, bears a dorsal hedge of stiff erect or even recurved hairs, which rise at the rear of the true gills and doubtless protect them from the ingress of silt. A few more scattering hairs rise also from the apical margin of segments 8 and 9.

The Oneida Lake specimens collected by F. C. Baker are No. 1048; and the Walnut Lake, Michigan, specimens were collected by T. L. Hankinson.

## SUPPLEMENTARY NOTE

A copy of the second part of Ekman's paper ('15) has become available as these pages go to press. The quantitative studies (pp. 401–411, pl. 6–14) are very interesting and clearly show the value of this kind of investigation. Following Petersen's method, Ekman has illustrated the number of individuals collected from an area of 5 dm. square. This unit area is 25 times greater than the unit area studied in Oneida Lake (1 dm. square or about 16 square inches). The Swedish lake is also much deeper than Oneida Lake and comparisons are not therefore strictly comparable. The results obtained from a study of this deep lake are of special interest for comparison with the shallower Oneida Lake and a few of Ekman's are shown in the table below:

| Depth in meters | Bottom | No. of species | No. of individuals |
|---|---|---|---|
| 15 | Sand | 21 | 78 |
| 13.5 | Sand | 17 | 51 |
| 23 | Sand | 35 | 250 |
| 26 | Sand | 21 | 96 |
| 31 | Chitingyttja | 20 | 351 |
| 53 | Sand | 15 | 142 |
| 73 | Sand | 35 | 250 |
| 82 | Sand | 11 | 33 |
| 102 | Chitingyttja | 12 | 68 |
| 112 | Chitingyttja | 17 | 364 |
| 120 | Chitingyttja, sand | 19 | 114 |

The table does not show a decrease in number of individuals with depth as was the case in Oneida Lake, but rather an increase with depth. It will be noted, however, that the greatest number of individuals, 351 and 364, occurred at depths of 31 and 112 meters, so that depth does not seem to be important in this lake. Compared with Oneida Lake the number of individuals are nearly twice as numerous in the American lake as in the Swedish lake. Similar studies on our deep lakes, Cayuga, Seneca, etc., would be of very great interest for comparison with Lake Vätter.

# INDEX *



* Reference to pages 92, 94, 96, 97, 101, 103, 107, 109, 138, 152, and 184, are to be unnumbered inserted tables facing these pages.

# ERRATA, TECHNICAL PUBLICATION N. Y. STATE COLLEGE OF FORESTRY, No. 4, 1916

Page 33. In figure 3 the horizontal scale should read 1 inch to the mile and the vertical scale ¼ inch = 100 feet, the error being due to the great reduction of the figure.

Page 168. The specimen (No. 327) recorded as *Moxostoma aureolum* has been determined as *Moxostoma breviceps* by Prof. T. L. Hankinson, and the two paragraphs on pp. 168-169 should be placed under the latter species.

Page 169. The dagger opposite the name *Moxostoma breviceps* should be removed. It has since been collected in Oneida Lake.

Page 173. The asterisk opposite the name of *Ictalurus punctatus* should be removed as it has been collected in Oneida Lake.

Page 194. Nineteenth line from top, for *Allorchesters,* read *Allorchestes.*

Page 205. Sixth line, for Forbes, read Forbes and Richardson; for *Lepomis megalotis* (Rafinesque) read *Lepomis auritus* Linn.

Page 207. Fifteenth line from top, for "very" read "vary."

Page 222. Eighth line from bottom, for *Chrysocharis* read *Chrysochloris.*

Page 252. Change *Margaritana margaritifera* to *Elliptio complanatus.*

Page 257. Change *Lampsilis borealis* to *Lampsilis radiata oneidensis.* The reasons for these changes are given in the present paper, pages 161 and 162. These changes should also be made on the tables throughout the paper.

Page 262. No. 3 of Fig. 43 is *Lampsilis luteola,* not *Lampsilis radiata.*

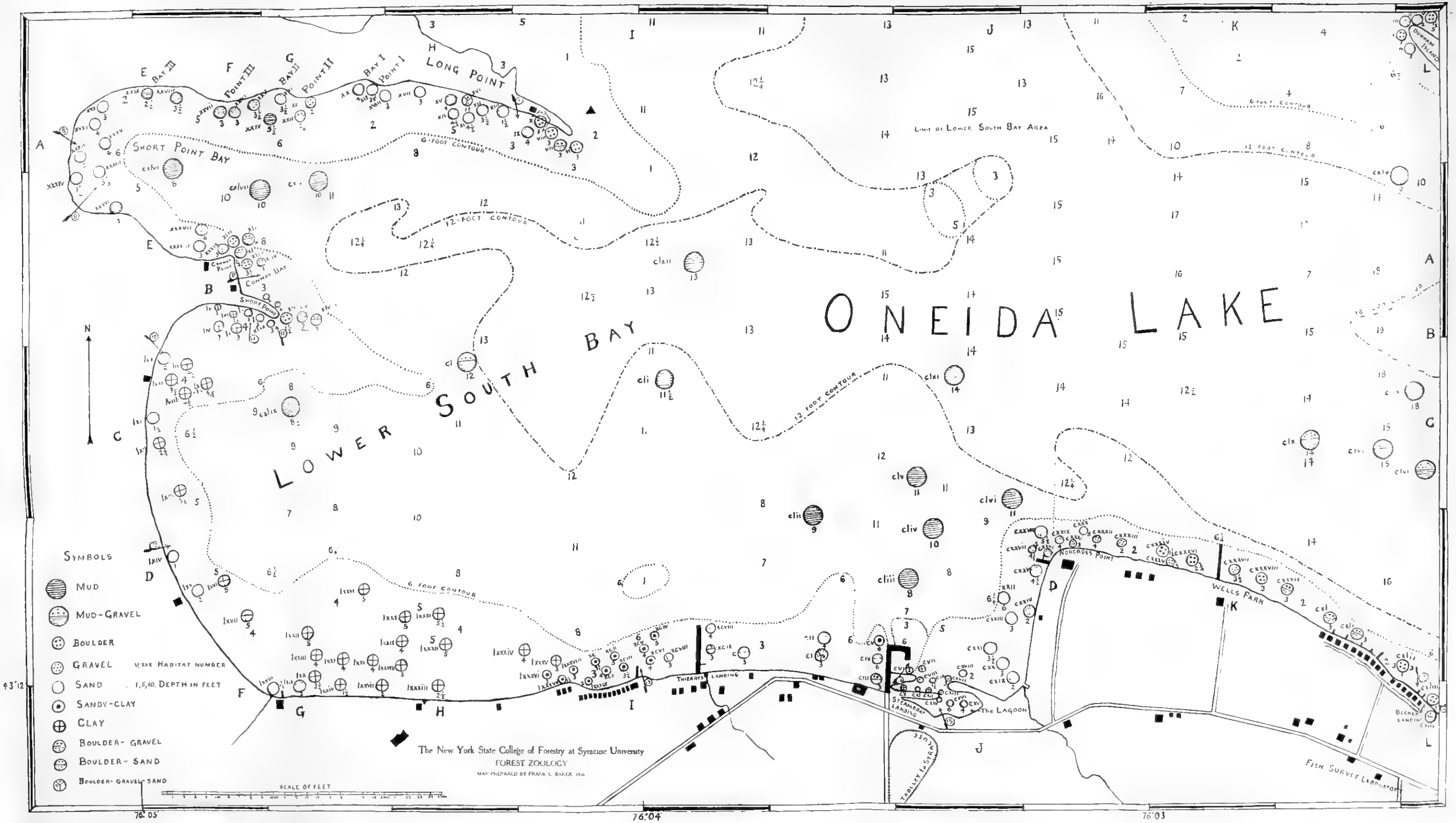
Page 266. No. 2 of Fig. 44 is *Lampsilis luteola,* not *Lampsilis borealis.* Nos. 1, 3, 4 are the new race *Lampsilis radiata oneidensis* Baker.

Page 270. Fig. 45, No. 21, is the new species *Amnicola oneida* Pilsbry.

Page 271. Species 41, for *bivarinata* read *bicarinata.*

Page 298. Fifth line from top, for leach read leech.

Page 316. Last line, for fool read food.


ONEIDA LAKE
LOWER SOUTH BAY
Limit of Lower South Bay Area
Short Point Bay
Long Point
Bay I
Point I
Bay II
Point II
Bay III
Point III
Conway Point
Conway Bay
Shore Point
Norcross Point
Wells Park
Dunham Island
Steamboat Landing
The Lagoon
Fish Survey Laboratory
Trolley to Syracuse
6 foot contour
12 foot contour
Symbols
Mud
Mud-Gravel
Boulder
Gravel
Sand
Sandy-Clay
Clay
Boulder-Gravel
Boulder-Sand
Boulder-Gravel-Sand
v, xxx Habitat number
1, 5, 10 Depth in feet
Scale of feet
43°12'
76°05'
76°04'
76°03'
The New York State College of Forestry at Syracuse University
FOREST ZOOLOGY
Map prepared by Frank C. Baker