XXXIV.—REPORT OF OPERATIONS AT CENTRAL STATION, UNITED STATES FISH COMMISSION, DURING 1882.

By MARSHALL McDONALD.

1. ORGANIZATION AND EQUIPMENT.

The Central Station of the United States Fish Commission is located in what is known as the old Armory Building, corner of Sixth and B streets, southwest, Washington, D. C. For some years under authority of Congress, it has been appropriated for the storage of the collections of the United States National Museum, as also of the reserve material and apparatus of the United States Fish Commission.

In the winter of 1881, when the distribution of carp by car and express shipment was substituted for the detached messenger shipments, it was found more economical and convenient, instead of drawing the fish directly from the tanks at the carp ponds for shipment, to bring them up in quantities to the Armory Building, and to arrange for the shipments from this point. For the convenience of this work several large tanks were constructed, each capable of holding for some days 12,000 to 15,000 carp. An abundant flow of fresh water through the tanks was obtained by drawing upon the city supply; and the fish, although very much crowded apparently, were thus kept in good condition for convenience of shipment. Experiments conducted during the previous season at the barge station on the Potomac River had demonstrated the practicability of transporting shad eggs from stations on the Potomac River 20 miles below Washington, and delivering them in good condition to the hatching station at the navy-yard.

During the latter part of this season this system, which is now known as the *dry method of transportation*, was substituted entirely for the method of transporting in buckets of water, which had been previously in use, the results being so entirely satisfactory as to give assurance that by having recourse to this method we would be no longer restricted to the necessity of establishing our hatching stations at points on the river, which, though convenient to the spawn-takers, are remote from the routes of transportation by which the young fish would have to be moved to distant waters.

The concentration of the work of propagation on the Potomac at Washington, in a locality convenient for observation and for shipment of the fry, promised important results to the Commission, both in awak-

ening a public interest in the work and in greatly cheapening the cost of distribution.

In obedience to instructions from the Commissioner, I accordingly submitted a programme for the organization, equipment, and conduct of central station for the work of propagation and distribution. It was determined to equip the station with the new hatching apparatus, based upon experiments conducted by me during the season of 1881. (For description of this, see Bulletin of the United States Fish Commission, Vol. III, p. 183.)

The water being drawn directly from the city supply, the available pressure at our command was sufficient to dispense with any arrangement for pumping, by which we were enabled to simplify greatly the organization and conduct of the work and reduce the cost of it.

The proper working of the automatic hatching jars depending upon the delivery of the water through them under a constant pressure, and the pressure in the city mains varying from hour to hour and day to day, it was necessary to devise some means to secure a constant head independent of the varying pressure. This was accomplished by placing upon the second floor of the Armory Building a tank with a capacity of 400 gallons of water, into which the water from the city mains was delivered directly, and thence distributed by suitable arrangement of pipes to ten tables occupying a section of the ground floor of the building. By automatic arrangements connected with the tank a constant level of water is maintained in it, and a constant pressure through the jars below. The construction of the tank and connecting pipes for supply and distribution is shown in Plate V. The distribution of water to each of the ten tables and the general arrangement of the interior of the hatching station is shown in Plate I. Each table is 15 feet long, 3 feet wide, and 39 inches high, this unusual height being given for convenience in observing and manipulating the jars. In the center of each table and extending nearly the entire length of it is a water-tight trough covered by a grating. The bottom of this trough has a slight inclination from one end to the other, and delivers the water collected from the discharge through the hatching jars into a waste pipe, which empties it all into the sewerage from the building. Each table can conveniently accommodate thirty jars, having each a capacity of 100,000 eggs, giving a total capacity to the station at one time of 30,000,000 eggs, and for the season of upwards of 200,000,000. This capacity can be increased to any extent desired.

In order to arrive definitely at accurate estimates of the number of eggs manipulated, and to determine the percentage of loss during incubation, a scale is employed, each division of which represents 10,000 eggs. By the application of this to the side of the jar, the eggs being allowed to subside to the bottom, the number of eggs contained in each can be read off accurately. An observation of this kind being made when the eggs are first placed in the jar, and a similar observation re-

peated when the hatching begins, gives us the means of arriving accurately at what had been previously very roughly and inaccurately estimated, namely, the percentage of loss during incubation.

The automatic action of the jars is sufficient to separate entirely the dead eggs from the living, so that when the hatching period approaches the fish-culturist in charge has only to deal with a mass of living eggs, the dead eggs being separated from them and carried off through the exit-tube from each jar, or are collected and fed to the fish in the different aquaria.

In order to provide for the collection of the young fry, when hatching begins, the discharge from the jars, instead of passing directly into the waste, is first conducted into aquaria conveniently placed along the center of each hatching table. To prevent overflow of this and loss of fish, a siphon is placed in each of the aquaria, the shorter end being terminated with a large wire cage covered by a bag of muslin, the longer end being immersed in a glass of water. The effect of this, when once a current of water is started, is to render the action of the siphon automatic and self-adjusting. Free exit is thus supplied for the water, and the straining surface of the muslin bag is so large as to prevent any perceptible suction through it, so that we are thus enabled to collect and hold the young fish in the receiving vessels until they have accumulated in quantity and for convenience of shipment. The arrangement of one of the tables for hatching and collecting is shown in detail in Plate IV.

Thus equipped, the Central Station of the United States Fish Commission entered upon the work of propagation.

2. PROPAGATION.

SHAD.—The methods employed in the transportation of eggs from the collecting stations on the river, as well as the apparatus used in hatching them at the station were novel, and a bold innovation upon the methods and apparatus in use up to that time. Though both had promised well in the experimental investigations conducted the previous season, they were now to be subjected to the test of practical application upon a large scale; and I am glad to be able to report that the results of the work done during the season justified our expectations.

The Navy-Yard Station and the Fish Hawk being both available for the work of shad propagation on the Potomac, it was determined to establish three independent stations, each drawing its supply of eggs from an independent section of the river. The Fish Hawk was stationed at Occoquan, and the lower section of the river, from Stump Neck to Stony Point, assigned as its theater of operations. The upper section of the river, extending from Moxley's Point to Washington, was assigned to the Navy-Yard Station, the Lookout being detailed for the collection and transportation of the eggs to the station. The middle section of the river, extending from Chapman's to Ferry Landing, was occupied

by the force of spawn-takers under my direction, one or more being stationed at each of the large fishing shores.

The Herreshoff launch was assigned for service in connection with Central Station, but being liable to detachment at any time, to take the place of the Lookout, in the conduct of the work at the Navy-Yard Station, it could only be relied upon for work of inspection. It was necessary, therefore, to make arrangements for the transportation of the impregnated eggs from the shores to Washington by public carriers. Arrangements were accordingly made with the steam-tug employed in running fish from the shores to Washington to receive and transport the crates of eggs, and to return the empty crates to the shores.

The irregularity of this service often delayed the movement of the eggs, so that in many cases they did not reach the hatching station until from twenty-four to thirty-six hours advanced in incubation.

When convenient the steamer Corcoran was also used as a means of transportation.

To have attempted under such circumstances the movement of the eggs in water would have involved total loss. The dry method of transportation, inaugurated in connection with the work of the previous season, was determined upon, and the men carefully instructed in the details of handling the eggs, with a view to securing the best results. The transportation crate employed in carrying out this method is shown in the figure, page 887. It consists of twenty shallow frames with wire bottoms. These, when stacked, are bound together by straps, so as to form a package convenient for shipping.

The eggs, as delivered to the station, were immediately transferred to the hatching jars, and the total number received ascertained by measure and recorded. The operation of receiving and transferring the eggs is well illustrated in Plate II.

To determine the percentage of unimpregnated and dead eggs on reception, a second measurement was made at the end of twelve hours, the difference between the two measures giving the percentage of dead and unimpregnated eggs; and the second measurement being the basis upon which our estimates of results in hatching are calculated.

Mr. W. F. Page was placed in charge of the hatching at Central Station, being assisted by details from time to time, as the emergencies of the work required.

The total number of eggs received, as shown by the summary of his report for the season, was 6,706,000; the number lost in incubation, 1,313,000; the total number of fish shipped (product of Central Station), 5,393,000; giving an average percentage of loss in incubation for the season of 19.5.

This percentage is higher than heretofore reported with the methods previously in use, and is to be attributed to the fact that in the use of these jars we have been able for the first time to arrive at an accurate estimate of the percentage of loss actually incurred. Such reports here-

tofore have been only crude guesses. That the percentage of loss was not unusual is shown by the fact that the number of fish produced, if counted by the standards previously employed by the Commission, would have been largely in excess of the entire number of eggs brought to the station.

The number of eggs furnished by Chapman's shore was 1,981,000. The yield of this shore the previous year was upwards of 20,000,000. The White House, which the previous season had furnished nearly 7,000,000 eggs, yielded in 1882 but 2,503,000.

The same proportional diminution of the crop occurred at all the shores occupied by our force of spawn-takers. The season was a disastrous one to the fishermen, the catch having fallen off materially from 1881. The falling off both in the number of fish and in the crop of eggs is probably to be attributed to the abnormal low conditions of temperature prevailing in the river during the season. The discussion of the observations of temperature and the relations of this to the run of fish will be found in another part of the Annual Report.

It is a matter of interest to record that nearly two-thirds of the entire number of eggs for the season were taken between the 25th of April and the 10th of May.

COD.—Early in February, 1882, experiments were instituted with a view of determining the possibility of transferring impregnated eggs of the codfish from New York to Washington, and hatching the same in artificially prepared sea-water at Central Station. Experts of the Commission were sent to New York to report to Mr. Eugene G. Blackford, at Fulton Market, who had made all preliminary arrangements for the conduct of the experiments.

In anticipation of the receipt of eggs arrangements were made at Central Station for circulation of salt water. These were briefly as follows:

A supply tank, into which the salt water was pumped by hand, and from which it flowed continuously through hatching apparatus similar to that employed at Wood's Holl in the season of 1881 and specially devised with a view to handling floating eggs. From the hatching apparatus the water passed into a receiving tank below, from which it was pumped again by hand into the supply tank; the limited amount of water used being kept in continuous circulation and as far as possible aerated in its circuit. To maintain the purity of the water a false bottom was placed in the supply tank, and over this a layer of animal charcoal, through which all the water was required to filter.

The salt water employed in the experiment was made from crystallized sea-salt, the amount used being 5 ounces to the gallon, giving a brine of about the density of the water at Wood's Holl.

The first eggs were received on February 16th, being forwarded on wire-bottomed trays covered with damp cloth. These eggs were a total loss. It was evident that the delicate membrane of the cod egg would not stand the shock of this method.

It was then determined to transfer the eggs in salt water in hermetically-sealed vessels; the temperature during transportation being carried down as nearly as possible to the freezing point, as it was expected that this low temperature would either suspend the development or slow down the rate to such an extent that the eggs would come through from New York to the station without asphyxiating. Several lots of eggs were received during the latter part of February, forwarded as indicated above, and a proportion of them in each case were found to be alive and developing. They were transferred to the hatching apparatus as received; but the results of the experiments were not encouraging. They were interesting, however, in the fact that in one case, especially, a small proportion of the eggs received were in good condition and continued to develop until the eleventh day, when the fish were plainly visible in the egg. We were not successful in hatching any, but it is a matter of interest to record that eggs taken, transported, and subjected to conditions during hatching, as above indicated, were carried along to a considerable distance toward hatching. The embryology of the egg was carefully studied by Mr. Ryder, and the results of his experiments, I presume, have been reported.

SALMONIDÆ.—To test the capabilities of the station for handling the eggs of salmonidæ, and the adaptability of the Potomac water for the incubation of these fall and winter spawning species, I was directed by the Commissioner of Fisheries to subject to incubation lots of eggs of all the species bred by the United States Fish Commission. Accordingly, upon requisition made and instructions received, the following lots were forwarded to the station:

Memorandum of eggs received at Central Station, winter season of 1882–'83.

Whitefish.—November 28, 1882, from Northville	1,000,000
Brook Trout.—November 28, 1882, from Northville	50,000
Brook Trout.—February 6, 1883, from Northville	72,000
Lake Trout.—November 28, 1882, from Northville	50,000
Rangeley Trout.—December 15, 1882, from Maine	20,000
California Trout.—February 3, 1883, from Shasta County, California	52,000
California Trout.—February 5, 1883, from Shasta County, California	22,000
Schoodic Salmon.—February 1, 1883, from Maine	5,000
Penobscot Salmon.—February 1, 1883, from Maine	220,000
Penobscot Salmon.—February 3, 1883, from Maine	120,000
Penobscot Salmon.—February 8, 1883, from Maine	80,000

With the exception of the whitefish, from which very fair results were obtained, it would appear that the conditions presented at this station are unfavorable for breeding the Salmonidæ; and we are compelled to abandon the expectation first entertained of using the station for work with these species, unless it be possible to secure well-water

in place of the Potomac water, as there is unquestionably something deleterious in its effect upon the Salmonidæ. Development up to the period of hatching seems to proceed under as favorable conditions here as elsewhere. The mortality after hatching, however, indicates something radically wrong in the conditions to which the fish are subjected. The 500,000 Penobscot salmon eggs received from the Maine Station were in the very best condition, and during incubation the percentage of loss was very small. The fry continued healthy for a considerable period after hatching until about the time of the absorption of the sac, when a heavy mortality set in, which no measures could arrest; so that of the original 500,000 eggs there remained for shipment but 424,000.

A summary of the results of the work with the Salmonidæ is shown in the following tables, prepared by Mr. W. F. Page from the records of the station:

Disposition of Penobscot salmon eggs received from Bucksport, Me.

1883.	Number of eggs received.	Lost before shipment.	Number of fish delivered for shipment.	Time of hatching.	
				Commenced.	Finished.
February 1	220,000	21,531	198,469	Mar. 8	Mar. 16
February 3	120,000	18,604	101,396	Mar. 5	Mar. 19
February 8	80,000	9,674	*70,326	Mar. 7	Mar. 24
February 24	80,000	15,275	64,725	Mar. 9	Mar. 26
March 30	5,000	5,000	.....	Apr. 6	Apr. 7
April 9	5,000	5,000	.....	Apr. 12	Apr. 12
April 20	5,009	5,009	.....	Apr. 24	Apr. 24
Total	515,009	80,093	434,916		

* Of these 10,000 were sent to the London Exhibition.

SHIPMENTS.

April 21—By Mr. Moore, car No. 1, to New York..... 225,000
April 24—By Mr. Moore, car No. 1, to New York..... 209,916

NOTE.—February 14, 1883, found one jar of eggs of the second lot, containing 15,000, shut off from fresh water (how long time not known) by reason of the clogging with trash and mud. Removed 4,509 smothered eggs. February 16, found a further resultant of 536 dead eggs. February 17 got 538 and February 19 got 204, making 5,787. It will be noticed that this is more than died in the regular course of hatching, out of the entire lot of 500,000.

Land-Locked Salmon from Grand Lake Stream, Maine, January 29, 1883 5,000
Shipped by Donnelly to Pennsylvania, April 19..... 1,467

Commenced hatching February 25, 1883. Finished February 28, 1883.

NOTE.—These eggs were shown at the Preliminary Fishery Exhibition at the National Museum, where the water was 6° or 8° higher than that at Central Station. This, undoubtedly, hastened the time of hatching.

Lake Trout from Northville, Mich., November 28, 1883..... 50,000
Sent to London Exhibition..... 7,000
Shipped fish 38,600

TIMES OF HATCHING.

Eggs taken.	Commenced hatching.	Finished hatching.
October 15 to 30	January 15, 1883	February 5, 1883
October 20 to 30	January 27, 1883	.....
October 25 to 30	January 29, 1883	March 1, 1883

SHIPMENTS.

April 10, 1883, by Messenger Donnelly to Fleming, N. C. . 35,000
April 19, 1883, by Messenger Davenport to Asheville, N. C.... 3,600

38,600

Brook Trout from Northville, Mich., November 28, 1882, Lot A. 50,000
Brook Trout from Northville, Mich., February 6, 1883, Lot B... 72,000

Distributed as follows:

LOT A.

April 4, 1883, Mr. Shaw, Benning's, District of Columbia..... 200
April 7, 1883, Donnelly, Bath County, Virginia..... 15,000
April 9, 1883, Moore, Woodmount, Md..... 8,000

23,200

LOT B.

April 10, 1883, Carswell, Albemarle County, Virginia..... 1,000
April 10, 1883, Carswell, Wytheville, Va..... 5,000
April 16, 1883, Donnelly, Wytheville, Va..... 2,500
April 17, 1883, Davenport, Rock Creek, Maryland..... 3,000

11,500

TIME OF HATCHING.

Eggs taken.	Commenced to hatch.	Finished hatching.
Lot A—October 22 to 29, 1882	January 15, 1883	February 15, 1883
October 31 to November 2, 1882	January 18, 1883	February 16, 1883
November 2 to November 6, 1882	January 20, 1883	February 26, 1883
Lot B—November 18 to November 23, 1882	February 9, 1883	March 20, 1883

CALIFORNIA TROUT.

Date.	Received from Baird, California.	Eggs shipped to North Carolina.	Fish shipped.
February 3, 1883	72,000	3,000	3,950
February 20, 1883	36,000	.....	5,750
March 22, 1883	14,000	.....	6,028
April 4, 1883	24,000	.....	500
April 14, 1883	45,000	.....	(*)
April 23, 1883	37,000	.....	(*)

*Forwarded to Wytheville.

SHIPMENTS OF FISH.

April 16, 1883, by Messenger Donnelly to Wytheville, Va..... 5,000
April 17, 1883, by Messenger Davenport to Rock Creek, Maryland..... 2,500
April 19, 1883, by Messenger Donnelly to Pennsylvania..... 2,000
April 24, 1883, by Messenger Donnelly to Maryland..... 6,728

Rangeley Trout from C. G. Atkins, December 15, 1882..... 20,000
Shipped, fish 15,000
Commenced hatching February 16, 1883. Finished March 4, 1883.

SHIPMENTS OF FISH.

April 9, 1883, by Mr. Moore, to Woodmount, Md	5,000
April 10, 1883, by Messenger Carswell, to Wytheville, Va	5,000
April 16, 1883, by Messenger Donnelly, Wytheville, Va.....	2,500
April 19, 1883, by Messenger Davenport, Asheville, N. C.....	2,500
	15,000

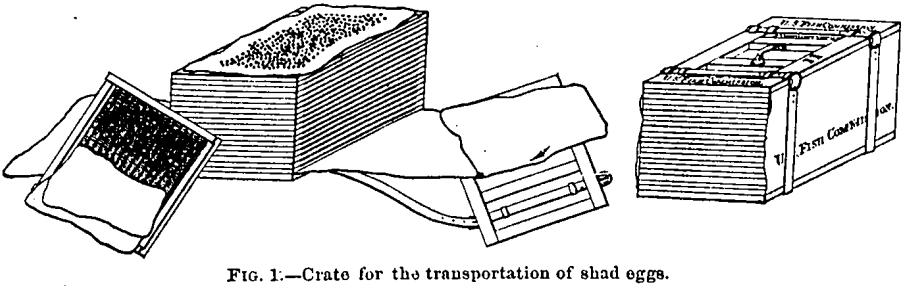


FIG. 1.—Crate for the transportation of shad eggs.

3. DISTRIBUTION.

Under the regulations of the United States Fish Commission the division of distribution is charged with the distribution of all eggs and fish sent out by the Commission, and with all arrangements and correspondence incident and preliminary thereto. The eggs of different species are usually sent from the collecting stations direct to applicants who have made request for the same, or to localities for which they are intended, the assignment, however, being made from Washington by the Commissioner.

The whitefish hatched at our stations in Michigan are sent direct from the stations to the waters for which they are intended, the transporting cars of the Commission being employed for this purpose.

The distribution of carp is made entirely through Central Station, as is also the great bulk of the shad fry, which are hatched for transportation and planting in other waters. The main work of the distribution is done through the instrumentality of the two cars belonging to the Commission, which are specially constructed and thoroughly equipped for this service. Detached messenger shipments are made use of only in cases where the character of the work to be done renders it inexpedient to send out the cars.

In the case of the carp, express shipments are largely resorted to, with the result of introducing great economy in the cost of distribution. Detailed reports of the distribution of carp and shad for the season of 1882 will be found elsewhere in the report.

HERRING.—On the 2d of May 2,000,000 herring were received from the steamer Fish Hawk for distribution. These were forwarded with a shipment of shad to the Colorado River, and deposited at Austin, Tex., May 16. The results of this effort to introduce herring into the Colorado will be looked forwarded to with much interest.

A tabular summary of the whitefish distribution made from our stations at Alpena and Northville, Mich., by car No. 1, is herewith submitted:

Distribution of whitefish eggs and fry in the United States and foreign countries, season of 1882–'83.

Date.	Place of deposit.	No. of fish.	No. of eggs.	To whom shipped.
1882.				
Nov. 26	.....	.....	[1] 1,000,000	Central station.
Dec. 18	Minnesota waters.....	[1] 200,000	.....	R. O. Sweeny, Minn.[4]
Dec. 22	Maryland waters	[1] 150,000	.....	Thomas Hughlett, Md.[4]
Dec. 24	.....	.....	[1] 250,000	S. G. Worth, N. C.[4]
Dec. 27	.....	.....	[1] 10,000	G. Ebrecht, Germany.[5]
Dec. 27	.....	.....	[1] 200,000	Société d'Acclimation.[5]
Dec. 27	.....	.....	[1] 500,000	Von Behr, Germany.[5]
Dec. 28	.....	.....	[1] 1,000,000	R. O. Sweeny, Minn.[4]
Dec. 30	.....	.....	[1] 1,000,000	R. O. Sweeny, Minn.[4]
1883.				
Jan. 1	.....	.....	[1] 250,000	S. R. Throckmorton, Cal.[4]
Jan. 3	New Hampshire waters.....	[1] 200,000	.....	A. H. Powers, N. H.[4]
Jan. 6	.....	.....	[1] 500,000	Von Behr, Germany.[5]
Jan. 8	.....	.....	[1] 1,000,000	R. O. Sweeny, Minn.[4]
Jan. 9	.....	.....	[1] 250,000	S. R. Throckmorton, Cal.[4]
Jan. 11	.....	.....	[1] 1,000,000	R. O. Sweeny, Minn.[4]
Jan. 12	.....	.....	[1] 1,000,000	R. O. Sweeny, Minn.[4]
Jan. 20	.....	.....	[1] 2,000,000	Seth Weeks, Corry, Pa.[4]
Feb. 12	.....	.....	[1] 1,000,000	E. G. Blackford, N. Y.[4]
Feb. 22	.....	.....	[1] 1,000,000	Charles G. Atkins, Me.[4]
Mar. 20	Nebraska waters	[2] 400,000	.....	B. E. B. Kennedy, Nebr.[4*]
Apr. 23	Lake Huron, Sulphur, Mich	[2] 2,000,000	.....	H. H. Buck, Orleans, Me.
Apr. 26	Eagle Lake	700,000	.....	
Apr. 26	Lake Michigan, Grand Haven, Mich	[2] 2,000,000	.....	
Apr. 28	Lake Huron, Alcona, Mich	[2] 3,000,000	.....	
Apr. 29	Lake Huron, North Point, Mich.....	[2] 2,000,000	.....	
Apr. 28	Lake Michigan, Ludington, Mich ...	[2] 2,000,000	.....	
May 2	Lake Michigan, Petoskey, Mich....	[2] 2,000,000	.....	
May 2	Lake Huron, Black River, Mich.....	[2] 2,000,000	.....	
May 5	Lake Michigan, Kenosha, Wis	[2] 2,000,000	.....	
May 5	Lake Michigan, Milwaukee, Wis...	[2] 1,000,000	.....	
May 7	Lake Huron, Oscoda, Mich.	[2] 2,000,000	.....	
May 10	Lake Superior, Marquette, Mich	[2] 2,000,000	.....	
May 12	Long Lake, Long Lake, Mich.....	[2] 100,000	.....	
May 15	Lake Superior, L'Anse, Mich	[2] 2,000,000	.....	
May 16	Lake Huron, Partridge Point, Mich.	[2] 2,000,000	.....	
May 19	Lake at Michigamme, Mich.....	[2] 1,000,000	.....	
May 22	Lake Michigan, Milwaukee, Wis....	[2] 1,000,000	.....	
1883.	Lake Ontario, Oswego, N. Y	[3] 3,000,000	.....	
1883.	Lake Ontario, Charlotte, N. Y	[3] 3,000,000	.....	
1883.	Lake Ontario, Oswego, N. Y	[3] 3,000,000	.....	
1883.	Lake Erie, Cleveland, Ohio	[2] 2,000,000	.....	
1883.	Lake Erie, Put in Bay, N. Y.....	[2] 2,000,000	.....	
1883.	Lake Erie, Put in Bay, N. Y.....	[2] 2,000,000	.....	
	Total	45,750,000	11,960,000	

* March 26, 1883. By Geo. H. H. Moore, charge car No. 1.
[1] Obtained from Northville, Mich.
[2] Obtained from Central station.
[3] Obtained from Alpena, Mich.
[4] Representing his State Commission.
[5] Through Fred Mather, New York City.

A review of the work done by the two cars during the season of 1882 gives the following interesting summary: The total number of miles traversed by car No. 1 in making the distribution of carp, shad, whitefish, and trout was 31,993, and by car No. 2, 25,354. The average cost per day per man for subsistence was, for car No. 1, $72\frac{43}{100}$ cents, and for car No. 2, 86½ cents.

The number of carp distributed by car service was 220,609; the number of white fish, 34,000,000; shad, 9,300,000; salmonidæ, 472,000.

4. EMBRYOLOGICAL AND EXPERIMENTAL INVESTIGATIONS.

A.—Professor Ryder's Investigations.

In connection with the work of shad propagation at Central Station, and during the progress of it, a series of interesting embryological studies were made by Professor Ryder. These embraced:

I.—Observations on the mode of absorption of the yelk of the embryo shad.

II.—Notice of an extraordinary hybrid between the shad and striped bass.

III.—Cause of the non-development of fungus on the eggs hatched in the McDonald jar.

IV.—Experiments with carbolic acid to kill the fungus on large fishes.

V.—Disturbance of the balance of conditions, and its influence on the crustacean food of the shad.

VI.—A means of demonstrating cartilage in fish embryos.

VII.—Methods of handling white perch ova.

VIII.—Notes on small fishes and water animals which prey on fish larvæ.

IX.—Observations on the food of the young Japanese gold-fishes.

X.—Experiments in supplying the proper food for larval shad.

XI.—Mechanical conditions affecting the development of fish ova.

XII.—Specific character of protoplasm.

A full account of these will be found in Bulletin of the United States Fish Commission, Vol. I, p. 179.

B.—Other Investigations.

A number of experiments were instituted under my direction by Mr. W. F. Page upon the eggs and fry of the shad with a view of determining the influence of different conditions upon the development of the eggs and the health of the fry. The results of these experiments as reported by Mr. Page are herewith appended.

No. 1. May 15. Held 25,000 young shad in asphalt can for seventeen hours without change of water. Afterwards shipped and deposited in good order. Temperature of water at station 53° F.

No. 2. May 16. Hatched 20,000 shad eggs over the oil stove (dark, cloudy day), using a water bath to diffuse the heat. All hatched in twelve minutes. Eggs were well developed, being in about twenty-four hours of their time of hatching naturally. Fish were strong and healthy, and were shipped on the following day by Mr. Newton Simmons to Kentucky, who reported they traveled excellently well with no loss. Temperature of water at station 53° F.

No. 3. May 20—9 a. m. Put 20,000 shad in a wood-bound can. Changed every three hours at 8 p. m.; delivered to Baltimore and Ohio Express Company, for shipment to Mr. Eugene Blackford, of Fulton Market, New York City. Also 4,000 in a small half-gallon pail, under same treatment, shipped at same time. A telegram from Mr. Blackford on the following day announced that in the wood-bound can the fish

were in good condition—only 5 per cent. dead. In small pail 25 per cent. were dead. Temperature of water in pail 54° F.

No. 4. June 4—10 a. m. Put 100 young shad in a pint and half of water. Water stood six inches in height in jar and had surface exposure of 3 inches in diameter. Placed in bottom of jar 24 scraps of sheet zinc ¼ inch by ⅝ inch long. All the fish were dead in thirty hours. The jar was exposed to diffused daylight, and was uncorked. Chemical analysis showed no trace of zinc in solution. Temperature of water at station 70° F.

No. 5. June 4—10 a. m. Put 100 shad under the same conditions precisely as in experiment No. 4, except no zinc or other metal was present. In this experiment all were alive when all were dead in No 4. June 7—10 a. m. Only 25 fish were dead. June 13—10 a. m. Fish have been dying very gradually for past several days. Removed none of the dead, allowing them to drop to the bottom. June 14—10 a. m. All dead. Temperature water used in station varying from 70° F. to 73° F.

No. 6. June 4—10 a. m. Put 100 shad under same conditions as in No. 5, except jar was wrapped and capped with ordinary writing paper stained with writing ink. Fish behaved just as in No. 5, and lived about as long. Could detect no difference.

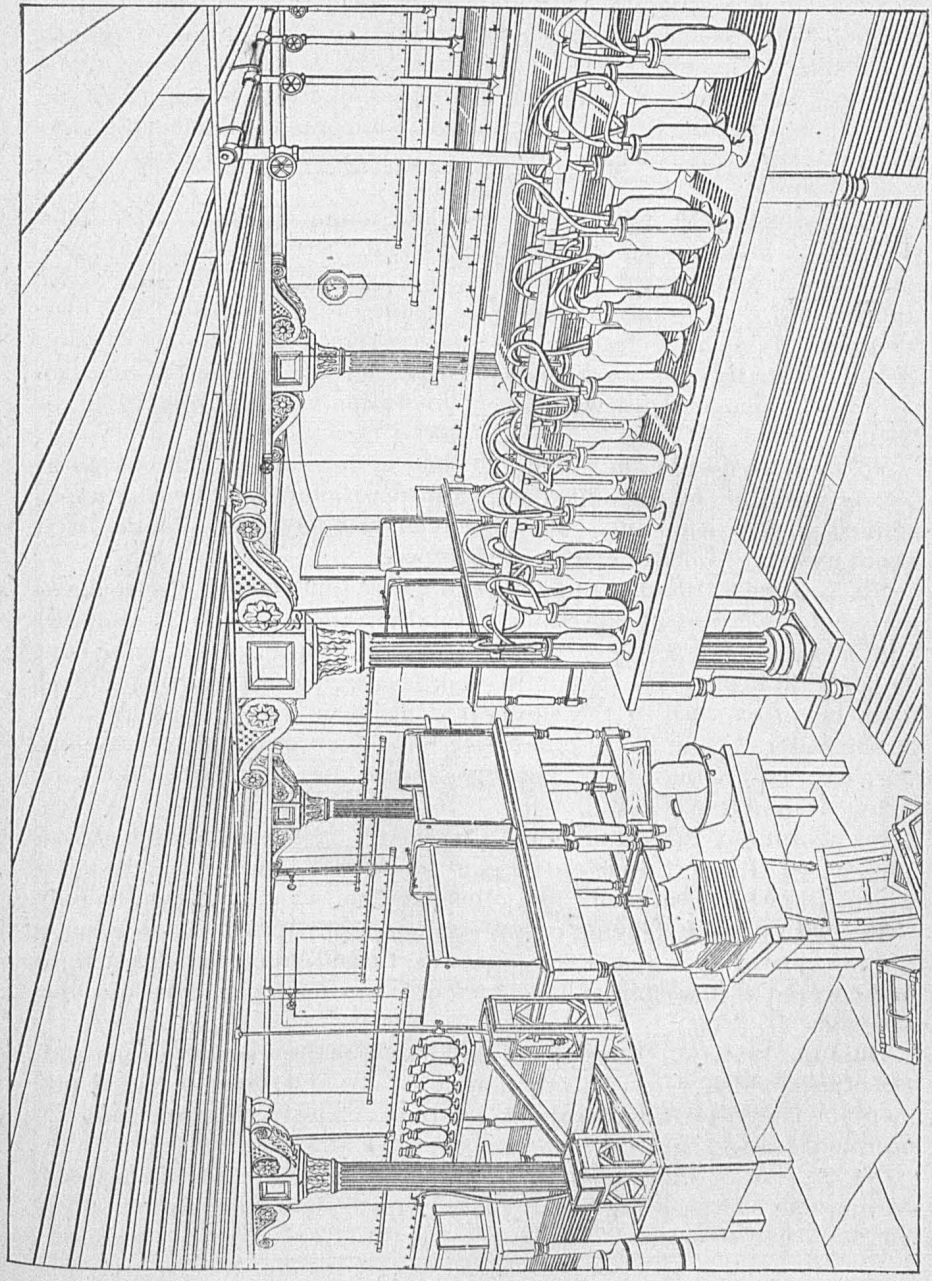
No. 7. June 4, 10 a m. Put 100 shad under same conditions as in experiment No. 5, except placed jar in total darkness as near as could be obtained and permit presence of outside air. June 7, 10 a. m. About 30 per cent. dead. The remaining fish became most violently agitated upon being exposed to the sunlight, some even jumping entirely out of the water. June 13, 10 a. m. Fish have been gradually dying since 7th; only 10 are now alive, and these weak, but agitated still by the light. June 14. All dead.

No. 8. June 7. Spawn-takers at Chapman's shore took 22,000 eggs at 10 p. m. on 7th; put them on trays at midnight; reached hatchway at 1 p. m., June 8, and were put in a McDonald jar which had been heavily coated with asphalt, leaving only a very small unpainted slot to observe the working of the eggs. This slot was turned from the direct light and covered with a flap of black paper when not opened to examine the eggs.

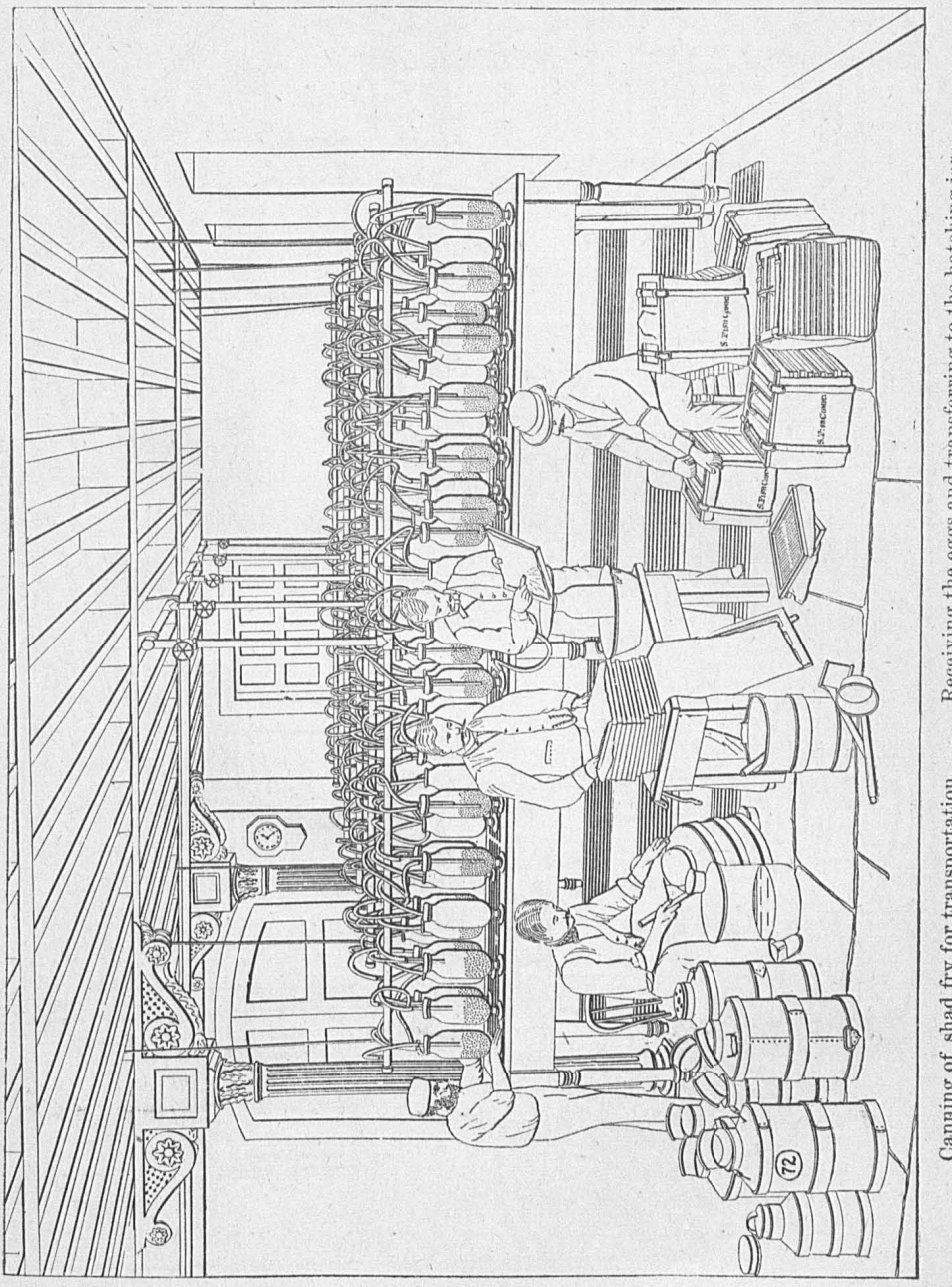
On June 12, a. m., the eggs finished hatching, producing fair percentage of fish. Fish were perfectly normal in size and development of pigments. They were afterwards placed in a separate aquarium and fed on live insects. July 12. Some are yet alive and growing.

No. 9. June 8. Placed 100 shad under same conditions as in No. 4, except zinc had been previously coated with asphalt and dried for thirty hours. June 10, 5 a. m. All dead.

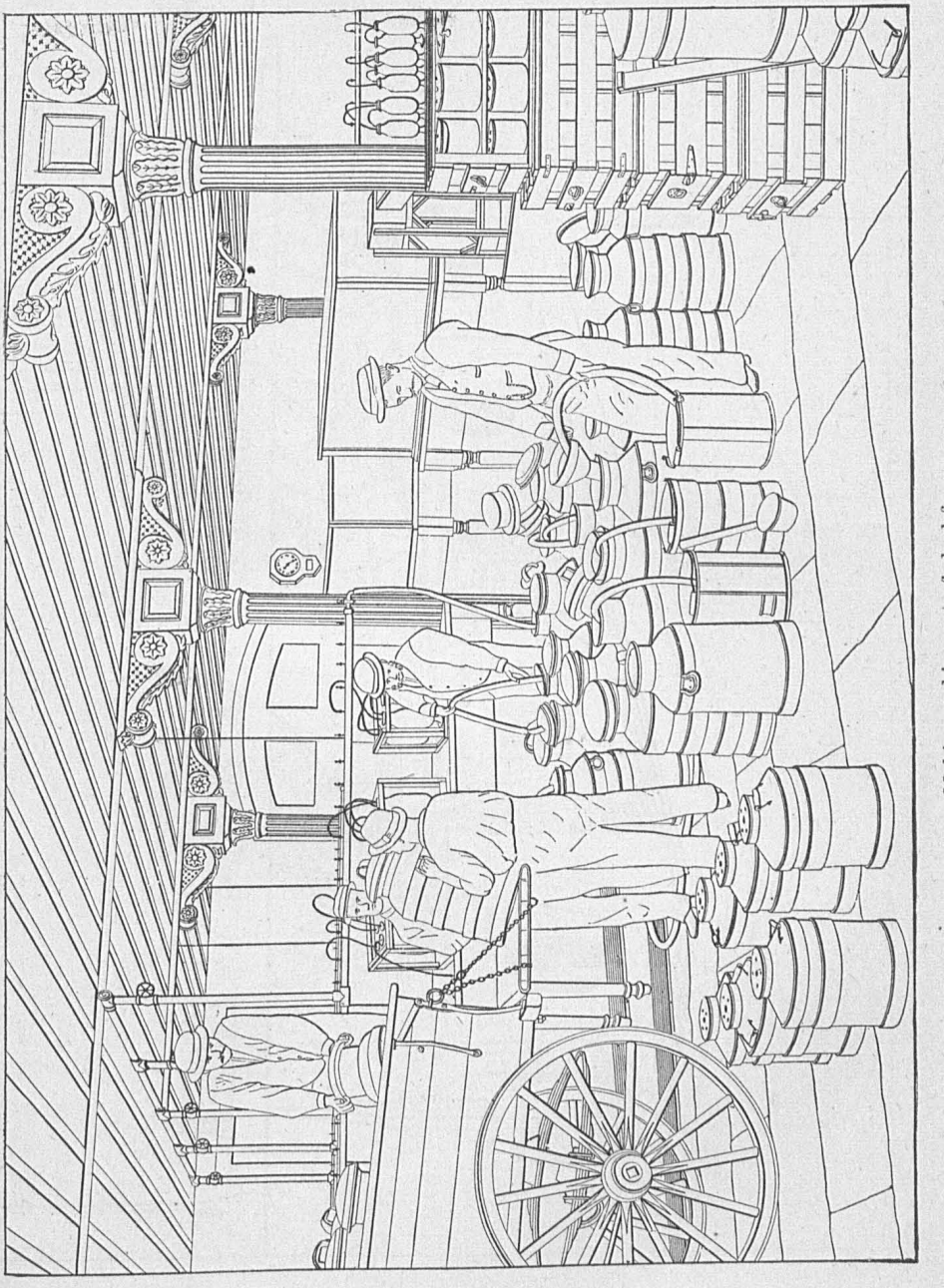
No. 10. June 8, 3.45 p. m. Same as experiment No. 5, except jar was yesterday morning coated inside with asphalt. June 9, 10 a. m. All the fish dead and jar very odoriferous of asphalt.



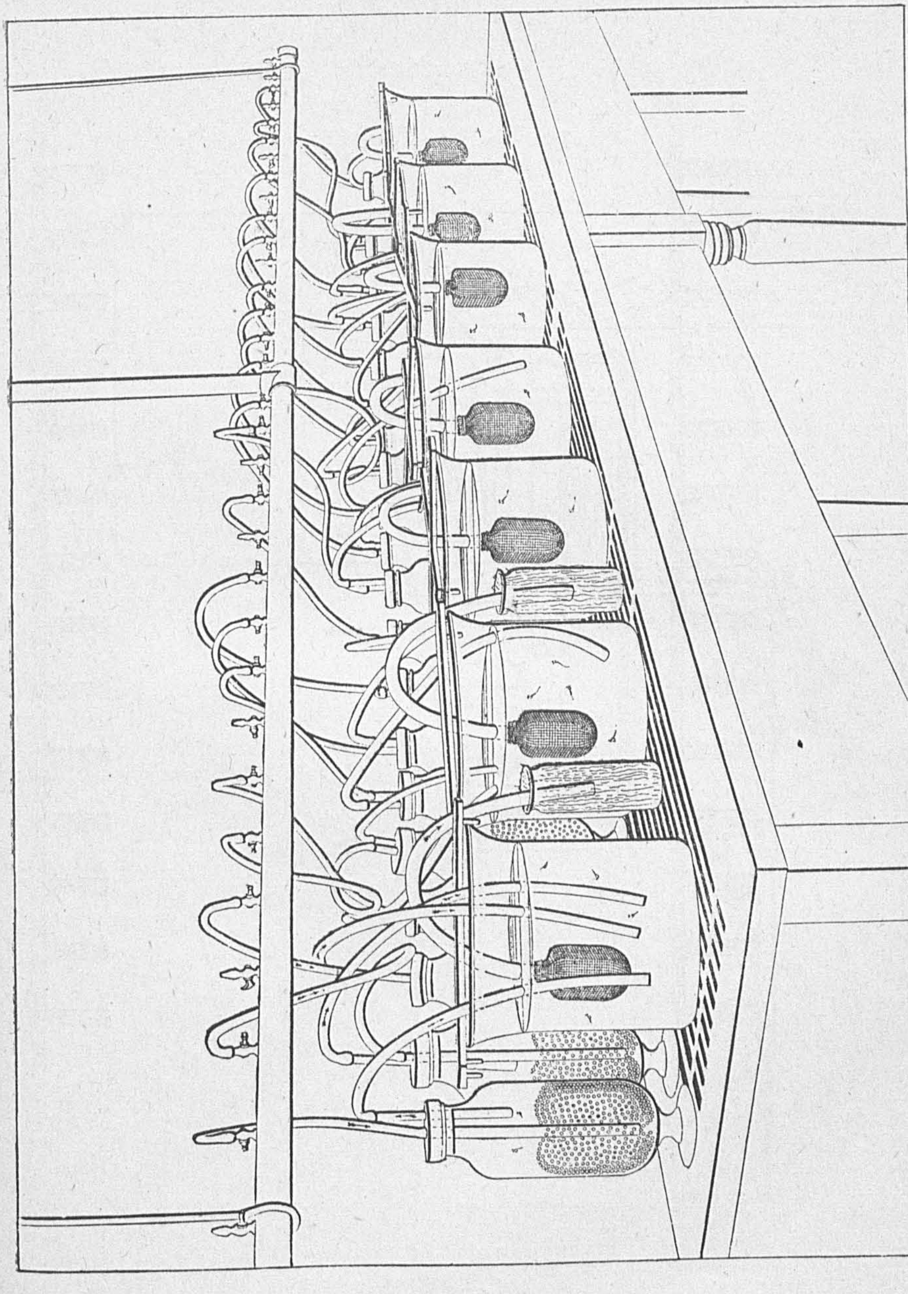
General view of interior of Central Hatching Station.



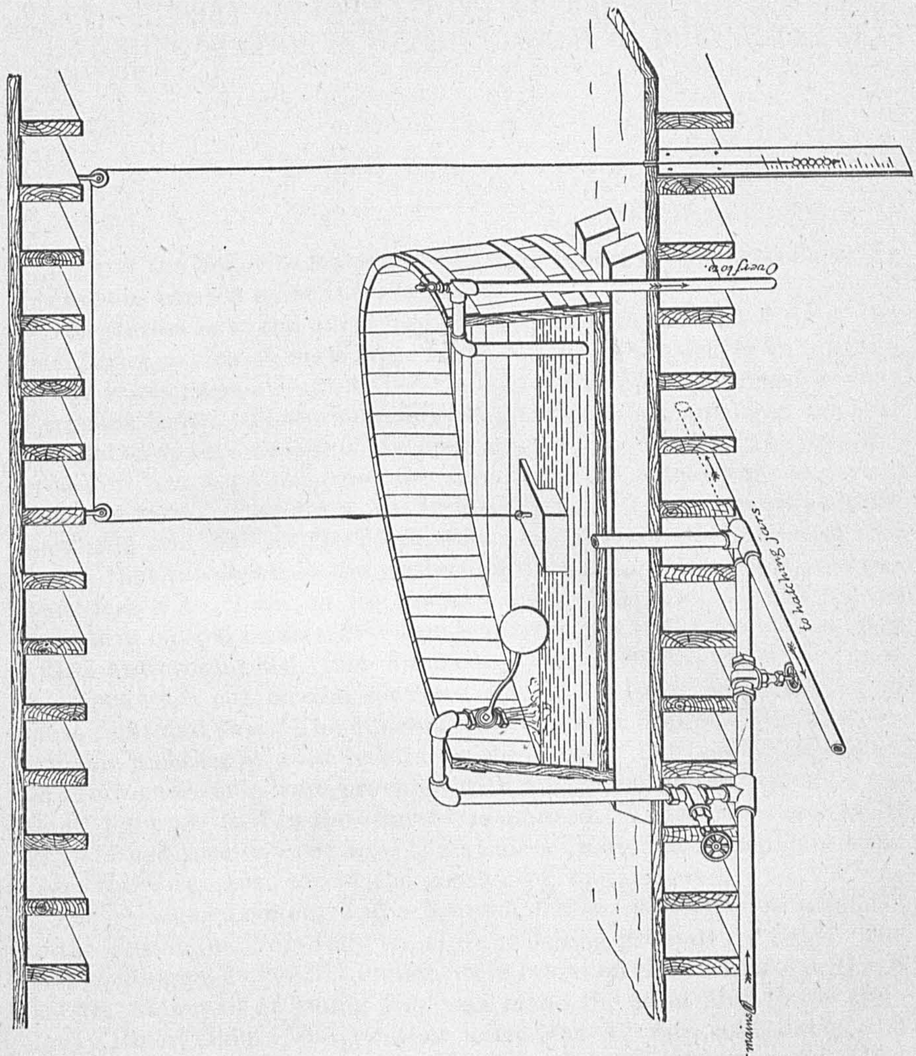
Canning of shad fry for transportation. Receiving the eggs and transferring to the hatching jars.



Making a shipment of shad fry.



Arrangement of hatching jars and aquaria for collecting fry of shad and whitefish as hatched.



Supply tank for regulating the head of water for the hatching jars under varying pressure in the water mains.