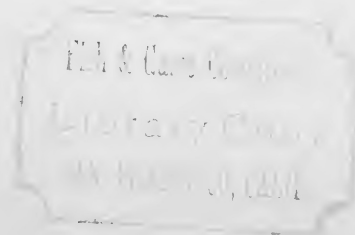

REPORT
OF THE
COMMISSIONERS OF FISHERIES
OF THE
STATE OF CALIFORNIA
FOR
THE YEARS 1878 AND 1879.

1*

MAR 24 1941





REPORT.

To His Excellency, William Irwin, Governor of California:

The Commissioners of Fisheries for the State of California, appointed under an Act of the Legislature, entitled "An Act to provide for the restoration and preservation of fish in the waters of the State," approved April 2d, 1870, respectfully submit their fifth biennial report.

We have to report an increasing public interest in fish culture and in the efforts of your Commissioners to continue the supply of valuable food fish in our waters. The destruction of fish during their seasons of reproduction, in defiance of law, once thought to be but a venial legal offense, is beginning to be considered a serious crime. As population increases, and railroads and other means of transportation are extended, there is a larger demand for fish; this is met by an increase in the numbers of fishermen, by extending the area of the fishing grounds, and by improved processes of capture.

SALMON (*ONCORHYNCHUS QUINNAT*).

One-half of the annual appropriation placed at the disposal of your Commissioners is expended in the hatching of salmon eggs and placing the young fry in the tributaries of the Sacramento River. From the organization of your Commission, and including the year 1879, we have had hatched and turned into the Sacramento River 13,150,000 young salmon; these, added to the natural supply, have been sufficient to make them as numerous in the river, during their seasons, as they have been at any time since so large an area of their spawning beds was destroyed by the operations of mining. Since our last report three additional establishments for the canning of salmon have been in operation on the Sacramento. If these establishments are to increase in numbers, with the consequent increase in the numbers of fishermen, boats, and nets, the supply of salmon cannot be kept up unless we add to the 2,500,000 of young salmon now annually placed in the river. To do this the appropriation must be increased, or we must abandon all other efforts at adding to the food fish of the State, and expend the whole appropriation in increasing the numbers of salmon. This last course would be unjust to large, important, and increasing interests in the State, and would be a violation of the intent of the law in creating the Commission. If there could be a faithful observance of the law that prohibits the catching of salmon during the close season; if the fish could have the river free from nets during these six weeks, and be allowed in peace to reach their spawning grounds, there would be no necessity for an increased appropriation, even if canning establishments were doubled and fishermen multiplied in the same proportion. During the close season, August 1st to September 15th, no salmon were pub-

2676- Cal. Sect. Mi.

licly exposed for sale in the markets, and outwardly the law seemed to be observed, but we have reason to believe they were caught and privately brought to San Francisco at night, and were served at hotels and restaurants to all who would call for them. The canning establishments ceased to purchase and tin salmon on the 1st of August, and, so far as we are advised, faithfully observed the law, but it is reported that many of the fishermen did not stop netting, and that more than one hundred tons of salt were sold in San Francisco about the 1st of August and shipped to by-places on the sloughs and islands of the Sacramento and San Joaquin, to be used in salting salmon during the close season. This illegal fishing is done at night, and the fish are taken before daylight to temporary shanties for salting and smoking, hidden in the wilderness of sloughs and tule islands. We have no means to prevent this violation of the law, and find but little disposition to assist on the part of the Justices of the Peace and Constables in the vicinity, who hold office by the votes of the men who violate the law.

The close season is now too short. Salmon in large numbers, with eggs fully matured, were on sale in the San Francisco and other markets from September 15th to the 1st of October, and yet we learn efforts will be made at the coming session of the Legislature to still further reduce it, or to change it to a time when there are no fish coming in from the ocean, or perhaps to completely abolish it. Experience in all the other States has demonstrated that fishermen as a class look only to their present profit, and are not willing to yield anything that the supply of fish in the river may be maintained.

The annual hatching of 2,500,000 of young salmon, and their distribution in the sources of the Sacramento, appear to keep the supply in the river equal to that of former years notwithstanding the increase in the number of sea lions protected by law, the increase in the nets and fishermen, and the erection of additional canning establishments.

The following table will show the relative catch for the years during which we have caused statistics to be obtained:

SALMON CAUGHT IN THE SACRAMENTO AND SAN JOAQUIN AND TRANSPORTED TO SAN FRANCISCO, SACRAMENTO, AND STOCKTON.

Open season November 1st, 1874, to August 1st, 1875	5,098,781 pounds.
Open season November 1st, 1875, to August 1st, 1876	5,311,423 pounds.
Open season November 1st, 1876, to August 1st, 1877	6,493,563 pounds.
Open season September 15th, 1877, to August 1st, 1878	6,520,768 pounds.
Open season September 15th, 1878, to August 1st, 1879	4,432,250 pounds.

The apparent falling off in the season of 1878-9 was not because the fish were not as numerous in the river as in former years, but in consequence of a dispute between the proprietors of the canning establishments and the fishermen as to the price to be paid by the former for the fish as they were caught. This dispute continued for some weeks during the height of the fishing season. The canning establishments stopped work, the fishermen formed an association and limited the catch to salmon for the supply of the San Francisco market. During this period but few fish were taken. The catch was, however, in excess of the requirements of San Francisco, and while the fishermen refused to sell average salmon on the fishing grounds to the canning establishments at twenty-five cents each, they forwarded them fifty miles to San Francisco and sold them for twenty-five cents and less. For a month the choicest salmon, weighing from sixteen to thirty pounds, could be bought from fishing boats at the

San Francisco wharves for one cent per pound. The dispute between the fishermen and the canning establishments, by which the river was practically open to the free run of the fish for nearly a month, will have one beneficial effect. It is equivalent to an increase in the length of the close season during the present year. The effect was soon observed on the McCloud and upper Sacramento. The spawning grounds were early filled with fish in greater numbers than ever before observed. The fish were so numerous in the McCloud before the fishermen renewed work on the lower Sacramento that in the pool at the United States Fishery, Mr. Livingston Stone, Deputy United States Fish Commissioner, estimated that in one haul of the seine he captured over two thousand salmon. From this dispute, resulting in an open river during the height of the run, thus allowing the fish to reach their spawning grounds, it is safe to predict an extraordinary run of salmon in the river in the season of 1883 and 1884.

The following report, made by Mr. H. D. Dunn, whom we employed to see if the law was obeyed during the close season on the Sacramento, and also to obtain statistics of the canning establishments, gives many facts of much importance. His statistics of the money invested in canning establishments on the Pacific Coast, and the number of cases put up during the past year, have much commercial interest. In his report he states:

In accordance with your directions, I visited Collinsville, Rio Vista, and Washington, on the Sacramento River, to inquire if there were violations of the close season for salmon, and to procure statistics of the quantities of that fish canned in 1878 and in 1879, up to the first of August. I have also collected all the data available of salmon canned in other portions of the State, and what amounts were put up in Oregon, British Columbia, and Alaska during the period named. With the single exception of the cannery located at Skeena River, British Columbia, I have obtained authoritative statistics, and herewith hand you statement of the same. The product of this cannery is mostly shipped to Great Britain via Victoria, Vancouver's Island, a small portion only of the catch of 1878 having been shipped in bond via San Francisco.

Owing to unfavorable circumstances, canning of salmon in California has this year been much less than during the same time in 1878. The spring run of salmon in the Sacramento came unusually early, commencing April 1st. The fishermen along the lower part of the river formed a combination, demanding forty cents per fish; the canneries offering twenty-five cents, as being all they could afford. The combination fishermen (mostly Greeks and Italians), by threats, and, in some instances, actual violence, prevented the delivery of any salmon from other boats at Collinsville and Chipps' Island canneries. The latter, however, obtained an insufficient and irregular supply of salmon by steamers from Rio Vista, which was subsequently much interfered with through the same means used in the vicinity of the canneries. Later the fishermen accepted the terms of the canners, and supplied fish; but the run ceased a few days later, the canneries closing June 6th. While the canneries at Collinsville and Chipps' Island were idle from want of fish, the cannery at Washington, Yolo County, procured a sufficiency at a less price than was refused by the lower river fishermen.

Being debarred supplying salmon to the Chipps' Island cannery, the fishermen (Germans), between Benicia and Montezuma Slough (a distance of 13 miles), made arrangements with a canning firm in San Francisco to put up and sell their catch, the total being about 6,000 cases. This firm expect to can more salmon this year, should the fall run (after September 15th) be sufficient, and, if the outlook is favorable, will continue in the business hereafter. The spring run of salmon in 1879 is reported as averaging twelve pounds per fish, dressed for canning. The market price for one pound salmon tins has been lower this year than before known—the ruling rates being \$1 05 @ \$1 10 per dozen.

Canners complain that the season for taking salmon is too short to admit of their doing a profitable business, and, that from the same cause, the fishermen cannot make a fair living and respect the law, without charging a higher price for fish than canners can pay and successfully compete with the put up of the Columbia River canners. They claim that, under the present law, the catch of salmon for canning purposes, does not last longer than six weeks on the Sacramento River, while it is fully four months on the Columbia River; that they have to prepare a full stock of cans in advance of the season's catch, and are put to many expenses for an entire year for not over six weeks' active work; that the spring run of salmon is irregular in times of arrival, varying as much as six weeks in different years. The spring run for canning in 1878 commenced May 15th, while this year there was a sufficient supply on March 29th to commence on.

While the canneries were idle in April, this year, large quantities of salmon were caught and sent to the markets in San Francisco, where they were sold in part at about freight charges, a great many spoiling and being thrown into the bay as unfit for any use. Adult salmon in large quantities are reported as sold in April, in this city, at from $3\frac{1}{2}$ to 6 cents each, the price rising May 1st to 15 and 20 cents each.

I have to report that, when at Collinsville on the 15th of August, I saw many salmon breaking in the river, and was informed by a Mr. W. Hosking, that at least 100 fish could be taken by a boat in making one drift of its net. From other parties I received information of violations of the close season, and while there I saw boats with nets going up the river to fish. Since my return I have seen letters from reputable persons, stating there were at least fifty boats out taking salmon in defiance of the law, and that one boat, containing 140 salmon, came to the wharf at Collinsville on 19th of August. The fish thus taken in defiance of law are mostly salted and smoked by the fishermen in the tules, a few probably being sent in a fresh state surreptitiously to this city. While on this subject, I desire to state my belief, that the Mr. Hosking referred to above is knowing to the continued violation of the salmon law, and from the circumstances of his position does much to encourage the same. He openly denounces the present law, keeps the only store at Collinsville, and does a large trade with the fishermen, who are more or less in his debt. He is Postmaster, Justice of the Peace, express agent, wharf keeper, and telegraph operator; so that all communications by letter or telegraph have to pass through his hands. The support of the citizens of Collinsville being largely derived from the salmon fishery, it would be difficult, if not impossible, to convict persons accused of violating the law under the circumstances stated.

COST OF CANNERIES IN CALIFORNIA.

Eight canneries, about \$25,000 each	\$200,000 00
Two hundred and twenty boats, about \$325 each	72,500 00
Two hundred and twenty nets, 250 fathoms each, \$300 each	66,000 00
One hundred and twenty scow-houses for men on the Sacramento River, about \$300 each	36,000 00
Total value of fixtures, etc.	\$374,500 00

No estimate is made for the boats and nets used at the canneries at Eel and Smith's Rivers.

Number of men employed in fishing, about 600.

Number of men employed in canneries, about 800.

Boats are 22 feet long, $6\frac{1}{2}$ feet beam, and 2 feet 6 inches deep; are sharp at both ends, have two lockers amidship to contain the fish, and have a large triangular sail.

The fishermen are all whites.

The can-makers are all whites.

The other workmen are all Chinese.

The catch of salmon in Smith's and Eel Rivers take place in September and October. The cannery at the latter place will not put up any salmon this year, owing to low prices ruling for such products.

STATEMENT OF SALMON CANNED IN CALIFORNIA IN 1878.

Two canneries at Collinsville, Solano County; one cannery at Chipp's Island, Solano County; one cannery at Rio Vista, Solano County; one cannery at Black Diamond Landing, Contra Costa County—total amount canned—cases	33,000
One cannery, Washington, Yolo County—cases	1,017
One cannery, Eel River, Mendocino County—cases	10,500
One cannery, Smith's River, Del Norte County—cases	4,277
Eight canneries—total cases, 4 dozen 1-lb cans	48,794

Average size of salmon dressed for canning, eleven pounds. The total number canned, about 222,000. Average value, \$5 40 per case, or \$263,487.

IN EIGHTEEN HUNDRED AND SEVENTY-NINE.

One cannery at Collinsville, Solano County—cases	588
One cannery at Chipp's Island, Solano County—cases	4,000
One cannery at Washington, Yolo County—cases	3,267
One cannery at San Francisco—cases	6,000
Four canneries—total cases	13,855

Number of salmon, about 67,523; average value, \$4 30 per case, or \$59,576.

The canning at Eel River will be closed this year. All the other canneries (except Rio Vista, which has been discontinued) will probably resume canning this year, if the fall run of fish should prove good.

COST OF CANNERIES, ETC., IN OREGON.

Thirty-five canneries, about \$25,000 each	\$875,000
Eight hundred boats in the Columbia River, \$325 each	260,000
Eight hundred nets in the Columbia River, \$300 each	240,000
Total	<u>\$1,375,000</u>

Nets in the Columbia River are about three hundred fathoms each. Number of boats, at five canneries not on the Columbia River, not known. Some of the canneries employ small steamers to collect salmon from the boats. Some few of the canneries on the Columbia River have cost from \$50,000 to \$60,000 each. About six thousand persons are employed in the canneries and fishing boats in Oregon, two-thirds of whom are Chinese. Average size of salmon when dressed for canning, fifteen pounds. The run of salmon in Oregon, except on the Columbia River, does not commence until August, and the catch at those places will not be known until late in the year.

STATEMENT OF SALMON CANNED IN OREGON, BRITISH COLUMBIA, AND ALASKA, IN EIGHTEEN HUNDRED AND SEVENTY-EIGHT.

One cannery at Sitka, Alaska—cases	2,750
One cannery at Prince of Wales Island, Alaska—cases	5,000
One cannery at Skeena River, British Columbia—cases	Unknown.
Seven canneries at Fraser River, British Columbia—cases	120,000
One cannery at Puget Sound, Washington Territory—cases	Closed.
One cannery at Gray's Harbor, Washington Territory—cases	5,420
Thirty canneries at Columbia River, Oregon—cases	445,000
Two canneries at Sinslaw River, Oregon—cases	10,300
Two canneries at Umpqua River, Oregon—cases	8,100
One cannery at Rogue River, Oregon—cases	8,000
Forty-seven canneries—total cases	<u>604,570</u>

Average value, \$5 40 per case, or \$3,264,578.

IN EIGHTEEN HUNDRED AND SEVENTY-NINE.

One cannery at Sitka—reported cases	7,000
One cannery at Prince of Wales Island—cases	7,000
One cannery at Skeena River—cases	Unknown.
Seven canneries at Fraser River—cases	15,000
One cannery at Puget Sound—cases	1,300
One cannery at Gray's Harbor—cases	Unknown.
Thirty canneries at Columbia River—reported cases	438,000
Two canneries at Sinslaw River—cases	Unknown.
Two canneries at Umpqua River—cases	Unknown.
One cannery at Rogue River—cases	Unknown.
Forty-seven canneries—total cases	<u>468,300</u>

Average value, \$4 30 per case, or \$2,013,690.

The catch at Gray's Harbor, Sinslaw, Umpqua, and Rogue Rivers is had in September, October, and November.

STATEMENT OF SALMON TAKEN FROM THE SACRAMENTO AND SAN JOAQUIN RIVERS, FROM SEPTEMBER FIFTEENTH, EIGHTEEN HUNDRED AND SEVENTY-SEVEN, TO AUGUST FIRST, EIGHTEEN HUNDRED AND SEVENTY-EIGHT.

65,046 loose salmon, weighing	1,626,150 pounds.
808 baskets and sacks of salmon, weighing	81,050 pounds.
2,361 boxes of salmon, weighing	170,715 pounds.
44 barrels of salmon, weighing	8,700 pounds.
48,794 cases canned salmon, weighing	<u>3,330,000 pounds.</u>
Total, say 304,411 salmon, weighing	<u>5,216,615 pounds.</u>
4,460 sturgeon, weighing	334,500 pounds.

STATEMENT OF SALMON TAKEN FROM THE SACRAMENTO AND SAN JOAQUIN RIVERS, FROM SEPTEMBER FIFTEENTH, EIGHTEEN HUNDRED AND SEVENTY-EIGHT, TO AUGUST FIRST, EIGHTEEN HUNDRED AND SEVENTY-NINE.

97,503 loose salmon, weighing-----	2,437,575 pounds.
312 sacks and baskets of salmon, weighing-----	37,740 pounds.
452 boxes of salmon, weighing-----	41,086 pounds.
18 barrels of salmon, weighing-----	4,950 pounds.
40 cases of smoked salmon, weighing-----	12,400 pounds.
13,855 cases of canned salmon, weighing-----	1,012,850 pounds.
Total, say 171,438 salmon, weighing-----	3,546,601 pounds.
7,104 sturgeon, weighing-----	607,800 pounds.

The above statements do not include the catch above Sacramento on the Sacramento River, or above Stockton on the San Joaquin River. In former reports we have added 25 per cent. to the figures reported as being a fair equivalent for the unreported catch above Sacramento and Stockton, and for the fish caught during the close season and salted and smoked in by-places in the tules. Adding this would make the catch of salmon of the season of 1877-8 as 6,520,768 pounds, and the season of 1878-9 as 4,433,250 pounds, as heretofore stated.

The catch of the season of 1877-8 was the largest of any since we commenced obtaining statistics, and is in fact the practical result of artificial hatching. Fish hatched in a given year do not begin to show in the returns until three or four years after the young fish are placed in the water. After nine years of study and observation, combined with considerable practical experience, we are prepared to answer the question as to the practicability of keeping up the supply of salmon in the Sacramento, notwithstanding the increase of population, extended facilities for transportation, and the multiplication of canning establishments, nets, and fishermen.

First—There must be an honest close season, faithfully observed by the fishermen, to allow a portion of the ripe fish to reach the spawning grounds. This would keep up a normal supply in the river, which normal supply would depend upon the area of clean gravel beds at the sources of the streams over which pure water was passing of a proper temperature. It would also give a supply of fish at the only places where their eggs could be taken for artificial hatching.

Second—The thousands of sea lions and seals at the Golden Gate and in the bay—carefully protected by legislative enactment—without doubt catch more fish annually than all the nets of the fishermen. These rapacious animals observe neither close season nor Sunday, live wholly on fish, and are unceasing in their work of destruction. They should be reduced in numbers or driven to some other part of the coast.

Third—A portion of the fish being allowed to reach their spawning grounds, and their destruction by sea lions and seals at the Golden Gate prevented, the number of salmon in this river would depend simply on the amount of money which the Legislature should deem proper to appropriate for the purpose.

After the female salmon escapes all her enemies in the ocean, the sea lions at the Golden Gate, the seals in the bay, and miles of nets in the river, and swims blindly against a stream of more than one hundred miles of muddy water thick with mining sediment and at last reaches the clean gravel beds of the ice-cold sources of the river

to perform the duties of maternity, she is still beset by numerous enemies. In the most favorable streams, the areas are not large—having proper beds of gravel, appropriate depth, and the right temperature of water—on which the eggs can be deposited. When the eggs are deposited, observation and experiment have shown that only an average of eight per cent. of them come in contact with the fertilizing sperm of the male—ninety-two per cent., of course, die. This eight per cent. is liable to be destroyed by trout and other fish, or to be smothered by a deposit of sediment caused by heavy rains on the summits of the mountains.

A mature female salmon of the Sacramento will yield 800 eggs to each pound in weight of the fish; thus, a fish of 20 pounds will yield 16,000 eggs. It has been estimated that, in a state of nature, not more than two eggs in a thousand ever become fish. This would give the product of the 16,000 eggs, 32 fish. By the discoveries in artificial hatching, these 16,000 eggs can be made to produce 15,000 fish. Every egg can be fertilized and kept under control and inspection in the most favorable conditions as to the current, purity, and temperature of the water, shaded from the direct rays of the sun, and closed securely against the almost innumerable finned, winged, and furred enemies that are seeking to devour it. The young fish, when they come from the egg, can be kept and fed until the most favorable period for placing them in the river. One million eggs can be taken, fecundated, hatched into young salmon, and turned into the river at an expense not to exceed \$1,200, and larger numbers at a less ratio. As they find in the ocean the food upon which they grow and become fat, they exhaust nothing from the river; therefore, if some fish are allowed to reach their spawning grounds, the number of salmon in the river can be in proportion to the amount of money the Legislature may see proper to appropriate for their artificial hatching.

WHITE FISH (COREGONUS ALBA).

Through the kindness of Professor Baird, United States Fish Commissioner, we have, since our last report, received from Lake Michigan, as a donation, nearly one million eggs of this most valuable food fish. The first lot of 300,000, which arrived January 20th, 1878, had been so kindly cared for by the agents of the express company that they were placed near the stove in the car, and were killed by the heat on the journey. The second lot arrived in good condition, and were successfully hatched out at the State hatching-house, San Leandro, and were distributed as follows:

January 11th, 1879—To Lake Tahoe, Donner Lake, and lakes at summit of Sierra	200,000
January 18th, 1879—To Eagle Lake, Lassen County	225,000
January 21st, 1879—To Tulare Lake	100,000
February 1st, 1879—Mark West Creek	10,000
February 17th, 1879—San José Water Company's reservoir	10,000
February 17th, 1879—Lake Chabot	20,000
Total	565,000

Some of the previous importations of these fish, planted in Tahoe, Tulare, and Clear Lakes, have thrived, and a few mature fish are reported as having been caught in each of these lakes. All of these bodies of water will, without doubt, within a few years, be stocked

with this valuable fish. As the white fish is only taken by nets, these lakes will be fully stocked before it will be found profitable for fishermen to make a business of catching them. A discovery of some importance in the care of the young of the white fish was made by Mr. J. G. Woodbury, in charge of the State hatching-house. This fish lives on the crustacea found on the rocks at the bottoms of deep lakes, and as it was not known on what the young fish could be fed, it has heretofore been necessary, within a few days after the young fish have emerged from the egg, to place them in the lakes to find their own food. Mr. Woodbury found that by pounding to a jelly the flesh of the common salt-water crab, the young white fish would eat and thrive upon it. He kept 50,000 on this food for more than two months. This discovery is of much interest, as it enables the young fish to be kept for some time, and thus distributed to stock mountain lakes that are inaccessible during the winter months.

SHAD (*ALOSA SAPIDISSIMA*).

In June, 1878, we received from Professor Baird, United States Fish Commissioner, from Havre de Grasse, 115,000 young shad; these were placed in the Sacramento River at Tehama, where all previous importations have been planted. The State has now received from the United States Government, and by our own importations, in all, 400,000 of these fish. There can be no doubt they find congenial homes in Pacific Coast waters, and are thriving and producing their kind. Several thousand mature fish have been taken and sold in the San Francisco markets during the spring of 1879. A few are found in market during almost every month in the year. After leaving the Sacramento River, the great body of these fish follow the coast south to the Bay of Monterey, where they must remain, finding an abundance of food; for a few are caught in the nets of the fishermen in this bay during every week throughout the year. If the appropriation were larger, we would do more towards stocking our rivers with this fish. No discovery has yet been made of any substance with which the young can be fed, and as seven days is the longest period they can be kept alive without food, we are compelled to take the number of young fish hatched from the eggs of one night's catch in an Atlantic river, and hurry them by express trains across the continent to Sacramento. The expense of such a journey with the necessary attendance, is almost \$1,800, and as the number of fish to be obtained is uncertain, a larger importation of young shad would involve an expense which would lessen the number of young salmon which it seems imperative we should supply to the river each season.

SCHUYLKILL CATFISH (*AMIURUS ALBIDUS*).

In 1874 we imported from the Raritan River, and placed in lakes near Sacramento, 74 of these valuable fish. These have increased to millions and furnish an immense supply of food. They have become so numerous that they are as regularly on sale in the city markets as the most abundant native fish, and are sold at about the same prices. They thrive in our rivers and lakes, and in the still-water sloughs of our plains, as well as in the brackish sloughs in our tule lands. They appear to be equally at home in lakes on the mountains and in artificial reservoirs in the valleys. Many farmers

who have natural ponds on their farms, or who have surplus water from wind-mills and have made artificial ponds, have stocked them with this excellent fish. The produce of the few fish of this species, imported in 1874, now annually furnishes a large and valuable supply of fish food to people in the interior of the State. The value of all the fish of this species, now caught annually and consumed as food, would more than equal the annual appropriation made by the State and placed at the disposal of the Fish Commissioners. This variety of catfish has valuable characteristics which admirably fit it for wide distribution and for self-preservation in the struggle for existence. The female makes a round nest in the bottom of a pond in which she deposits usually from 3,000 to 5,000 eggs. These are fecundated by the male who then leaves them to the care of the female. The mother remains over them fanning them with her fins, probably to keep them oxygenated with fresh currents of water, as well as to prevent them being smothered by sediment. She remains in constant attendance, driving away every fish that approaches her nest. In from six to ten days the young make their appearance. Her care does not cease with the birth of the young fish. She now swims about them in a circle, keeping them together until all are hatched. When all the young fish are fitted to swim she leads them off to find food, still keeping them in a body by circling about them and driving back wanderers, as a trained shepherd dog drives in a wandering sheep; she will at the same time fight any other fish that comes near her charge. In another week or ten days they are prepared to search for their own food, when they gradually disperse. Since our last report we have distributed 39,000 of these fish to public waters to stock rivers, ponds, and reservoirs in the Counties of Butte, San Joaquin, Yuba, Sonoma, Ventura, San Diego, Sacramento, Placer, El Dorado, Alameda, Colusa, Yolo, Sutter, Nevada, Stanislaus, Tuolumne, Modoc, Los Angeles, Mono, Solano, Mendocino, and Lassen.

LAND-LOCKED SALMON (*SALMO SEBAGO?*).

In January, 1878, through the kindness of Professor Spencer F. Baird, United States Fish Commissioner, we received from the United States hatching-house of Grand Lake Stream, Maine, 50,000 eggs of the land-locked salmon. This fish is found in a few lakes in the northern part of the State of Maine. In structure they are the same as the Atlantic salmon (*salmo salar*). They have probably been derived from the Atlantic salmon, which, by some natural cause at a remote period, were prevented from returning to the ocean. Their descendants, finding sufficient food in these lakes, have lost the instinct which compelled their ancestors to return to the ocean, and they are now fitted to live continuously and breed in fresh water streams and lakes. As was stated in our last report, the California salmon (*quinnat*) has the same characteristics, and readily adapts itself to a life in fresh water. The reservoir of the Spring Valley Water Company, supplying San Francisco with water, and known as San Andreas and Pilarcitos, are well stocked with salmon, the product of those prevented from returning to the ocean by the constructions of the dams. Lake Chabot, the reservoir from which the City of Oakland is supplied with water, is also well stocked by the same means, and from young salmon placed therein. In the winter of 1875-6 a large number of young salmon were placed in the Truckee

River. This river has its rise in Lake Tahoe and flows into Pyramid Lake, in Nevada, and has no outlet to the ocean. Some of these salmon are reported to have been taken with the hook in the Truckee River this season, weighing from three and a half to five pounds. The size to which the Sacramento salmon will grow when confined to fresh water depends upon the quantity of food to be found in the lake or stream. A few years after the dam was erected at the San Andreas reservoir salmon were taken in it weighing from six to twelve pounds. In ten years they have multiplied until hardly any other fish are taken, but now do not average to exceed three-fourths of a pound. They now mature their eggs and milt when less than a pound in weight. The land-locked salmon of Maine do not average over six pounds in weight, but they are numerous in the lakes, furnish a large amount of food, and yield much sport to the angler, as they readily take both fly and bait. As they are natives of the cold lakes of Maine we have thought the most appropriate places for the distribution of the young fish would be in our mountain lakes; but, for purposes of testing their fitness to thrive in warmer waters, a portion were also distributed to lakes in the valley and on the coast, as follows:

March 16th, 1878—Donner Lake and other lakes near the summit.....	10,000
March 20th, 1878—San Francisquito Creek, Espenosa Lake, etc.....	10,000
April 6th, 1878—Tulare Lake	15,000
April 7th, 1878—San Leandro Creek and Lake.....	2,500
April 8th, 1878—Arroyo Laguna, near Sunol	700
April 19th, 1878—Reservoir at Alms House, San Francisco.....	1,000
April 30th, 1878—Echo Lake, El Dorado County.....	250

EASTERN BROOK TROUT (*SALMO FONTINALIS*), PACIFIC COAST BROOK TROUT (*SALMO IRIDEA*), DOLLY VARDEN TROUT (*SALMO CAMPBELLII*), AND TAHOE TROUT (*SALMO TSUPPITCH*).

In January, 1878, and in January, 1879, we received from Wisconsin and New Hampshire 70,000 eggs of the Eastern trout. The young fish were hatched at the State hatching-house, San Leandro, and were distributed as follows:

March 1st, 1878—Streams in Santa Barbara County	5,000
March 16th, 1878—North Fork of the American, Prosser Creek, and Truckee River.....	10,000
March 19th, 1878—Kaweha River, Tulare County	5,000
March 20th, 1878—Carmel and streams in Monterey County	7,000
March 25th, 1878—Streams in Alameda County	2,000
March 26th, 1878—San Leandro Creek, Alameda County	5,000
March 30th, 1878—Russian River and Sulphur Creek, Sonoma County	6,000
April 5th, 1878—Santa Rosa and Mark West Creeks, Sonoma County	3,000
April 5th, 1878—Streams in Santa Cruz County.....	2,000
April 5th, 1878—Streams in San Mateo and Santa Cruz Counties.....	4,000
April 8th, 1878—Alameda Creek and tributaries, Alameda County.....	2,000
April 15th, 1878—Calaveras Creek and small streams, Alameda County	2,000
March 1st, 1878—North Fork of American, South Yuba, and tributaries of Truckee River.....	20,000
March 29th, 1878—Yosemite Valley	1,000

Of the trout eggs of California trout procured from McCloud River, the young fish were distributed as follows:

March 30th, 1878—Russian River and tributaries	6,000
March 30th, 1878—Santa Rosa and Mark West Creeks.....	3,000
April 5th, 1878—Santa Cruz, Aptos Creeks, etc.	4,000
April 8th, 1878—Alameda Creek and tributaries	2,500
April 7th, 1878—Streams in Santa Clara County.....	2,000
April 18th, 1878—Streams in Santa Cruz County.....	10,000
May 9th, 1878—San Lorenzo Creek, Alameda County	1,000
May 9th, 1878—Streams in Alameda County	5,000
March 21st, 1879—Streams in Santa Cruz and San Mateo Counties.....	7,500
March 27th, 1879—Streams in Santa Clara and Monterey Counties.....	9,000
March 29th, 1879—Yosemite Valley	20,000
April 1st, 1879—San Gregorio and Pescadero Creeks, San Mateo and Santa Cruz Counties	8,000
April 1st, 1879—Streams in Alameda County	1,000
April 3d, 1879—Tulolumne River	2,000
April 7th, 1879—Streams in San Mateo County.....	7,000
April 15th, 1879—Streams in Alameda County.....	6,700

The few Dolly Varden trout that we succeeded in hatching were distributed in streams at the summit, and in the Truckee River.

In September we purchased 50,000 young Tahoe trout that had been hatched by Mr. Frazer, and distributed them in the Truckee River, in the North Fork of the American, and in the South Yuba. These fish were placed in the Truckee on the petition of the people residing on that river, who complained that for some years the trout in that stream had been gradually decreasing in numbers. There are now fish ladders over the dams on the Truckee, and, if maintained, it is probable a supply of trout can be kept up in this river.

The eastern trout does not appear to thrive in the streams of the Coast Range of mountains. These mountains are composed of sand stone, which is readily worn by the winter rains and, at certain seasons, all the streams from them carry a large amount of sediment and become more or less discolored. There is also a great difference in the temperature of the water in winter and summer. The native home of the eastern trout, as its name implies, is in the clear cold sources of mountain streams. Wherever planted in the cold clear streams of the Sierra Nevada, in water flowing over granite and slate, they find congenial homes, and thrive and propagate equally with the native trout.

Probably there is no trout more valuable for wide distribution than the Pacific Coast brook trout (*Iridea*). It grows rapidly, occasionally weighing seven pounds when it can feed in salt water at the mouths of coast streams, and often weighing five pounds when confined entirely to fresh water containing an abundance of food, as in the McCloud River. Some specimens of McCloud trout, kept in the hatching-trough in the fishery at San Leandro, grew to average seven inches in length in one year from the time the eggs were placed in the hatching trays. It does not seem to be injuriously affected by a long continuance in water containing a large amount of muddy sediment. We are not aware of experiments having been made to test, with exactness, the highest temperature of water in which it will exist and thrive, but without doubt it will live in water so warm as to be fatal to eastern trout. We believe it could be successfully introduced into streams on the Atlantic Coast where eastern trout would not thrive.

LOBSTERS (*HOMARUS AMERICANUS*); EELS (*ANGUILLA*); STRIPED BASS (*ROCCUS LINEATUS*), AND BLACK BASS (*MICROPTERUS NIGRICANS*).

In 1874, with the aid and experience of Mr. Livingston Stone, we made the attempt to stock the waters of the Bay of San Francisco with lobsters. Mr. Stone left Boston in a car prepared with all the appliances then known for transporting fresh and salt water fish. One portion of his charge consisted of 150 lobsters. With the exception of four all of these died on the journey. These four were placed in the Bay of San Francisco at the end of the Oakland pier. They were alive, but seemed feeble, and we had small hope that they would survive and propagate. Since that time reports have been made that young lobsters have been caught in the bay. An examination of all that have been brought to us, as young lobsters, has shown that they belonged to some other family of crustacea. (In July of the present year (1879), Mr. Livingston Stone again made the attempt to bring lobsters, eels, striped bass, and black bass from the Atlantic States.) Availing himself of his experience obtained in former journeys, and having learned by repeated experiments a method of retaining ocean water in a state of purity in small tanks, he succeeded, by constant work and assiduous attention, in bringing from the Atlantic Ocean and depositing in the Pacific Ocean at the Golden Gate, 24 female lobsters. It is estimated that these lobsters had attached to them more than two million eggs, all of which would hatch within a week from the time they were deposited. We believe we can now look forward with confidence to the time when lobsters will be found in abundance in our waters.

In 1874 a few young eels were brought from the Atlantic and planted in lakes near Sacramento, and others in the Bay of San Francisco, near Brooklyn. We have no reports of those placed in the salt-water. Several have been taken in the fresh-water, near Sacramento, full grown, and three feet in length. Finding they would thrive, we obtained, through Mr. Stone, 4,000, which, in July, were planted, one-half in the Sacramento River, and the other half in Alameda Creek. Without doubt they will, in a few years, fill our streams.

At the same time Mr. Stone brought from the Neversink River, New Jersey, 150 young striped bass, which were successfully turned into the brackish water of the Sacramento River, at Martinez. It is to be hoped they will escape the nets of fishermen, the sea lions, and seals. Should a few pair survive their enemies and propagate they will add a most valuable food fish to our salt, brackish, and fresh-waters.

The 73 black bass brought in the aquarium car of 1874 were planted in Napa River. A number of these were caught in 1875, and probably all were exterminated by anglers, who could not wait until time had been given the fish to breed. We can hear of none having been caught during the past two years. We have again made the attempt to introduce this valuable fish. In July last Mr. Stone again brought 24 black bass, and 22 fully mature fish were placed in the Crystal Spring reservoir of the Spring Valley Water Company, in San Mateo County. We have the assurance of the officers of the company that this reservoir shall be preserved, and no fishing allowed in it for three years, or until such time as we desire to take young bass for stocking other waters.

CARP (*CARASSIUS VULGARIS*).

We have been unable as yet to introduce the king carp, with which to stock our inland sloughs and warm water lakes. This, the most valuable variety of the carp family, was imported from Germany by Professor Baird, United States Fish Commissioner, a few years since, and has increased to large numbers in ponds at Washington and Baltimore. They could not be obtained in July, at the time Mr. Stone left with fish for California. We now hope to receive the State's quota in June, 1880, with another consignment of young shad. It is certain they will thrive in California, as another variety of carp, imported as a private speculation some years since, has been extensively distributed over California, and now furnish a large amount of food to people in the interior valleys. We do not know any fish so desirable for wide distribution throughout the State as this carp. They are of good flavor, grow rapidly, are tenacious of life, can live on aquatic vegetation, and in water too warm for almost all other valuable varieties of food fish. We can hardly do a more useful work than in the breeding of these fish, and stocking all our interior streams, lakes, and sloughs with carp.

FISH-WAYS.

We have caused a few suits to be commenced to compel the owners of dams to construct fish ladders. In almost all cases, when notified, the owners of dams have complied with the law. It is generally understood by the people of the State, that to preserve fish in our rivers, it is absolutely necessary that fish should be allowed to reach their spawning grounds. The efforts of your Commissioners to keep up the supplies of fish in our rivers, and to add new and valuable varieties, appear to be appreciated, and we find there is in almost every neighborhood some man who has sufficient interest in the subject to call our attention to obstructions when such exist.

OCEAN AND BAY FISH.

More than ninety varieties of fish are caught in the Bay of San Francisco, and in the Bays of Monterey and Tomales, which are sold for food in the San Francisco market and shipped to various points in the interior. This gives employment to many hundred men, and their work furnishes a vast amount of food to our people. So far as we have been able to ascertain, but one variety is identical with an Atlantic Coast fish (the halibut). The consumption of fish is so large on this coast that it seemed desirable to obtain the statistics in relation to it. We have found this very difficult. Many of the fishermen are Greeks, Italians, Portuguese, and Chinese, who do not speak English, and few keep a written record of their catch. The dealers do not care to exhibit their books. Many of our fish are without English names, and one English name is made to apply to different varieties of fish. Two of the varieties of fish sold as smelts in our markets do not belong to this family. Three different fish are sold as candle fish, etc. Where fish, as in the case of salmon, are mostly brought to market by transportation companies, the annual catch can be ascertained with approximate correctness. At present it seems impossible to obtain statistics of the catch and consumption of

salt-water fish. Not being able to obtain these facts, it then seemed desirable to know what salt-water fish furnish the largest amount of food to our people? What are their names, and in what months are they most numerous? To ascertain these facts and make a record of them, we obtained the valuable services of Mr. W. N. Lockington, who for some years has been making a study of the fish of this coast, and who has added to the science of ichthyology several new varieties. Mr. Lockington has watched the market for a year, keeping a record of all the varieties of fish sold as food, their first appearance, abundance, and disappearance. His report, which follows, will be found of great value, as it is the first attempt to collate, classify, and name the various fish which make their appearance in the San Francisco markets during a year.

APPROPRIATION AND EXPENSES.

A detailed statement of the appropriation received and expenses incurred will be found at the close of this report. We are gratified that the work of the Commissioners appears to be approved by the public. We may be pardoned in the expression of the belief that not many other of the State's appropriations produce more beneficial and practical results. When fish valuable for human food are introduced into barren waters, or when valuable fish are made to supplant worthless kinds, the beneficial results are not confined to the present time and to the present generation of men. With that better observance of wise laws for the preservation of fish that is sure to come with increased intelligence these beneficial results will spread and increase, and the produces from the fish now introduced and planted will furnish food to those who come after us so long as our streams continue to flow, and while our lakes and reservoirs continue to hold water.

REPORT UPON THE FOOD FISHES OF SAN FRANCISCO

BY W. N. LOCKINGTON.

About ninety species of fishes are brought in greater or less numbers to the markets of San Francisco, either at certain seasons or during the greater portion of the year. Most of these are in esteem as food fishes, while the remainder, either from their scarcity, their small size, their repulsive appearance, or their actual deficiency of flavor, are not usually eaten by people of European descent, though some of the more abundant kinds are in favor with the Mongolians.

In the following pages it is proposed to bring together a few facts relating to the comparative abundance, seasonal and geographical distribution, size, etc., of the various species used to any extent as articles of food, together with such notes upon their food and habits as the limited opportunities of the writer have enabled him to collect. Particular care will be taken to point out some of the more obvious characters of each species, so that any one interested in the important subject of our fish supply may be able to distinguish them. Little attempt at technical description will be made, and the synonymy will be limited to the recognized name of each species, together with, in some cases where a change has recently been made, the title given by its original describer. The writer regrets the paucity of his original information, but a beginning must be made, and he trusts that all who are in possession of facts relating to our fishes will report the same to him or to the Fish Commissioners.

The groups of fishes which are of most importance, from an economical point of view, are the *Salmonidæ* (using the word in its old meaning), the *Embiotocidæ* or viviparous perch, a family almost confined to this coast; the *Pleuronectidæ* or flat-fishes, and the rather heterogeneous group commonly known by the English name of rock-fish or rock-cod, and comprising numerous species of the family *Scorpenidæ*, with others belonging to the *Chiridæ*.

Probably the *Salmonidæ*, including as it does the *quinnat* and other anadromous salmon, together with the lake and brook trouts and the smelts, is the most important of these groups, since the *quinnat* and other species of the genus *Oncorhynchus* not only furnish a large proportion of the fish supply of this coast, but are canned in large quantities for exportation.

As the particulars of the salmon supply, with the details of the work done in hatching and preserving the young of these valuable fishes, have been given in the regular report of the Fish Commissioners, the present report will deal only with the small marine species of the group. It would not be easy to say which of the other three groups mentioned above is of most importance as food, since each of them contains from thirteen to eighteen species, some or other of which are plentiful during every season of the year; but the three contain the greater proportion of the individuals and spe-

cies usually sold in the markets. Next to them come the sturgeon, the *Sciaenidæ*, which family furnishes two valued species, the *Atherinidæ*, or so-called smelts, and lastly the *Gadidæ*, or codfish, and the *Clupeidæ*, or herrings, two families which do not occupy the prominent position accorded to them elsewhere, since only one or two species of each are sufficiently abundant to form an important item in the total-fish supply. Several species of *Scombridæ* (mackerel, as the family was defined by the older naturalists) occur along the coast of California, but none of these are taken, except occasionally, in the immediate vicinity of San Francisco, and none of them are brought to our markets either regularly or plentifully.

With the exception of a single species of skate, all the marine fishes habitually eaten by the white residents of the city belong to one or other of the families enumerated above.

The quantity of fresh-water fishes (excluding the salmon) brought to our markets is not very large, and consists chiefly of four species of *cyprinidæ* (*Eventognathi*, Gill) and the Sacramento perch.

Certain introduced fishes are now becoming sufficiently abundant to be worthy of enumeration among our food fishes, although they are only occasionally brought to market, and are sold at a high price. These are the shad, *Alosa sapidissima*, the Prussian carp, *Carassius vulgaris*, and a species of catfish, *Amiurus albidus*. The first of these is still very scarce, and fetches a very high price, but some examples attain quite respectable dimensions, and the supply is tolerably constant. The largest I have seen measured twenty-six inches in length by seven in width; another was twenty inches long by five and a half wide; and a third intermediate between these. The Prussian carp was first introduced by Mr. Poppe, of Sonoma County, but has since been raised at other places. Those sent to the market were from Port Harford.

During the time that the writer has systematically watched the market he has been so fortunate as to discover several new species of fishes, of which three belonging to the *Pleuronectidæ*, a *Lycodoid*, and a *Scomberoid*, are of more or less value as food fishes. This occurrence of previously undescribed species, as well as the abundance of numerous other species formerly little known, may be partially attributed to the fact that the fishermen now trawl in deeper water than formerly, going to thirty-six fathoms or more, and partially to the facility with which, now that railway communication is established, the fishermen of Monterey and other places can send their catch to San Francisco. In the days when Dr. Ayres watched the markets and described so many of our fishes, the Monterey fishermen did not have the advantage of supplying the San Francisco market; on the contrary, the fishers of our bay sent a portion of their catch to points between San Francisco and Monterey that are now supplied by the Monterey fishermen. This competition, together with the vast quantities taken out of the bay by the Chinese, the havoc worked by the protected legion of sea lions at the entrance of the Golden Gate, and the want of any close time for the more useful kinds of fishes, threaten, in the course of time, to make the local fishery unremunerative to the hard-working men engaged in it. It is much to be regretted that the white fishermen themselves, by their indiscriminate destruction of young fishes, and uncompromising slaughter of adults during the spawning season, appear anxious to hasten that destruction.

Already the fishery carried on in the Bay of San Francisco is much less productive than it was in the early days of the American occupation; species that were once common have become scarce, and others still tolerably abundant fail to attain their full dimensions. Nor is over-fishing the sole cause of this. The constant hurrying to and fro of the numerous ferry-boats and other steamers, indispensable to our comfort, tends to drive away the timid finny tribes, whilst the ashes and cinders let fall injure the character of the bottom.

But the injury from this source is small compared with that inflicted by the constant fouling of the waters and consequent destruction of life by the foetid inpourings of our sewers; by that foolish waste of organic substances, which has now become an integral part of what we consider civilization, materials which, if spread upon the land, would cause our sandy wildernesses and bald hill-sides to bear a luxuriant crop of cereals, and would thus bring life, or, which is almost the same, the means of life, to thousands of human beings, are now poured into the waters to pollute them for the destruction of creatures on which human beings are largely dependant for the means of life. As the supply in San Francisco Bay has become limited the scene of wholesale destruction is now shifted to Tomales Bay, whence a very large proportion of our fish supply is now brought. Although the fishes of the cod family are not prominent among the supply of fresh fish sold in the markets, codfish are extremely abundant on the shores of British Columbia, Alaska, and Kamtschatka, and about thirteen vessels belonging to San Francisco are engaged in the cod fishery, which is carried on in much the same manner as that of the Newfoundland Banks. Rather the larger portion of the catch, which in 1878 amounted to about 1,500 tons, is taken in the Okhotsk Sea, the remainder principally at the Shoumagin Islands. The greater part of the supply is consumed in California; but some is sent to South American ports upon the Pacific, and even to Australia. The drying of these fish is not done upon the spot, but at drying establishments on the shores of San Francisco Bay. The fishery is at present carried on in comparatively shallow water, although, as in the Atlantic, it is observed that the fish from deeper water are the best. The cod of the Pacific cod-fishery is a true *Gadus*; but, as no entire specimens have yet been carefully examined, it is uncertain whether it is to be referred to *Gadus auratus*, Cope, or to one of the species described by older writers.

Small quantities of halibut (*Hippoglossus vulgaris*?), herring (*Clupea mirabilis*), and eulachon (*Thaleichthys pacificus*), are preserved in various ways for the San Francisco market, but these branches of our fisheries are in their infancy.

The halibut is abundant, attains large dimensions, and is probably equal in every respect to that of the Atlantic, yet it cannot compete in San Francisco with the Eastern article. It is occasionally canned like the salmon.

The eulachon is one of the fishes which, from their oiliness and the use made of them by the Indians, are called "candle-fish." Some are brought down in salt, while others are put up with oil in boxes and sold as sardines.

SUBCLASS TELEOSTEI, BONY FISHES.

In the fishes of this subclass, the skeleton is more or less ossified, instead of cartilaginous, as in most of the *Ganoidei* (sturgeon, etc.), and in the *Elasmobranchii* (sharks, rays, etc.). The caudal fin is regular or homocercal, rarely absent; the optic nerves from opposite sides simply

cross without forming a network or chiasma; the arterial bulb of the heart is simple, and provided with two valves at its origin; the air bladder is simply what its name denotes, never becoming cellular or lung-like; opercles or gill-covers are always present, and the body is usually covered with scales, though in some cases scaleless, or with prickles or bony plates in lieu of scales. This subclass comprises all those vertebrates usually called fishes, except the somewhat miscellaneous group *Ganoidei*, of which the sturgeons are the only representatives upon the coast of California; the *Elasmobranchii*, comprising the sharks and rays, which are not generally used for food; the *Marsipobranchii* or lampreys and hags, the former often eaten; and the *Leptocardii* or lancelets, the lowest of vertebrates, if indeed they are entitled to that name at all.

The *Teleostei*, according to Professor Gill's classification, are divided into the orders *Teleocephali* or ordinary fishes; *Nematognathi* or silurians, comprising the catfishes and numerous other forms, chiefly fresh-water, all characterized by the presence of from four to eight long barbels around the mouth, the longest a continuation of the incomplete maxillary, and with numerous other characters which render them a compact group; *Apodes* or eel-like fishes, having no ventrals, the scapular arch or shoulder-girdle free from the skull, instead of attached to it as in the other orders, and an elongated, snake-like body; *Pediculati*, including a few strange forms in which the pectoral fins are carried by elongated bones, which foreshadow those of the forelimbs of higher vertebrates, and which have small gill openings behind the pectorals; *Plectognathi*, balloon fishes, etc., which have the intermaxillary and maxillary bones firmly united; and *Lophobranchii*, pipe fishes, which have their gills in small tufts instead of in long comb-like series, as is the case in all the preceding orders, and the mouth small and toothless, placed at the end of a long snout. Besides these are the two small orders *Scyphophori* and *Opisthomi*, neither represented on this coast. As all the indigenous *Teleostei* of California, ordinarily used as articles of food, belong to the first of these orders, *Teleocephali*, it may be as well to dismiss the others with a few words so as to avoid future reference to them.

Although the order *Nematognathi* has numerous representatives in North America (Jordan, catalogue of fresh-water fishes, pages 414-415, enumerates 28), and may be said to have its headquarters in South America, not a single species is indigenous in the streams of the Pacific Coast; and the order *Apodes* is not represented in the neighborhood of San Francisco. Here, then, we have two remarkable features of our fish fauna, no catfishes and no eels in our rivers, for though several kinds of fishes, both fresh-water and marine, are often called eels, they are only elongated *Teleocephali* or else lampreys. The *Pediculati* are represented in Lower California, but not in Upper California. Only a single *Plectognath* fish is ever brought to our markets, although another species occurs in the southern part of California, and the order has several representatives farther south. This solitary *Plectognath* is the wide-spread *Orthogoriscus mola* or sun-fish, if, as seems probable, it is really identical with that Atlantic species. I have not yet had the good fortune to meet with a fresh example, but a small specimen is in the Museum of the California Academy of Sciences, and a larger, about three feet long, in the collections at Woodward's Gardens. In the Proceedings of the California Academy of Sciences of 1867, page 141, Mr. R. E. C. Stearns mentions the occurrence in the market of a specimen, 5 feet 8½ inches in extreme length, and 7 feet 6 inches in width from tip of dorsal to tip of axal. The small specimen, on which Dr. Ayers founded his *Orthogoriscus analis*, was taken in Santa Barbara Channel.

The *Lophobranchii* are represented in our bay by two species of pipe-fishes, *Syngnathus dimidiatus* and *Syngnathus griseolineatus*, both occasionally brought to market, but both too small to be used as food, and in the more southern part of our coast by *Hippocampus ingens*, the great Californian sea-horse, of which our museum possesses a single specimen.

The *Teleocephali* include the greater part of the orders *Mulacopteri*, *Anacanthini*, and *Acanthopteri* of older naturalists, but as Professor Jordan well remarks, "however different the extremes of each (as *Percoids* and *Cyprinoids*) may be, the intervening forms are too closely related to render it possible to characterize them as distinct orders."

The suborders now recognized in this large order are the *Heterosomata* or flat-fishes, the *Anacanthini*, the *Acanthopteri*, the *Percosoces*, the *Hemibranchii*, the *Syngnathii*, the *Haplomi*, the *Isospondyli*, the *Eventognathi* or carp tribe, and the *Gymmonoti*. Of the last tribe, the electric eels, we have no examples; the *Hemibranchii* or half-gilled fishes, chiefly consisting of the small tribe of sticklebacks, too small for use as food, and of the *Fistularians*, need not here be considered; and the *Syngnathii* or gar-pikes, and the *Haplomi* do not occur in our markets. Representatives of the other suborders, which, after all the other classes, orders, and suborders are taken away, still include far the greater proportion of the families, genera, and species of gill-breathing vertebrates, are numerous here as in most other parts of the world. A noticeable feature of the California fish fauna is the almost total absence of *Acanthopterous* or spiny-finned fishes from the fresh-waters, which are stocked almost wholly by the *Salmonida* (a family of *Isospondyli*), and by the *Eventognathi* or throat-jawed fishes.

ORDER TELEOCEPHALI.

Bony fishes with terminal mouths, the maxillaries and intermaxillaries distinct, and well developed pectinated (or comb-like) gills; gill openings in front of pectorals and comparatively wide; and a sub-operculum (this bone is absent in the order *Nematognathi*). Scales usually present, and generally cycloid or ctenoid.

SUBORDER ACANTHOPTERI.

Telcocephali normally with ctenoid scales, a spinous dorsal fin, either separate, or forming the anterior portion of a single dorsal; one or more spines in front of the anal, and an articulate first ventral ray. One or other of these characters often fails, but a constant character is the absence of the ductus pneumaticus, or tube connecting the swim-bladder with the gullet.

PERCIDE.

This large group of typical *Acanthopercous* fishes, with spinous fins and highly ctenoid scales, is, by some naturalists, divided into several families or sub-families, two of which, the *Serranidae* and the *Centrarchidae*, each send to our markets a single representative, the first occasionally, the second with tolerable regularity.

Archoplites interruptus, Girard, Sacramento River Perch—This species is abundant along the lower course of the Sacramento and San Joaquin Rivers, and in all branches of those rivers that permeate the low lands, and forms an important article of food not only to the white inhabitants of the district but also to the Chinese, who are particularly fond of it, catch it in immense numbers and forward it to their countrymen along the railroad, as far as the boundary of the State, or even beyond it. It is usually taken in fyke-nets, which are most effective engines of destruction. It is a very good fish for the table, unless taken in sloughs that, by the falling of the water, have become disconnected with the river. During the winter months this species was rarely brought to the markets of San Francisco, but from February to September it has been of constant occurrence. Although usually known as the Sacramento River Perch, it is by no means confined to that river and its tributaries. Professor Jordan (Bulletin, United States National Museum, 10, p. 34) gives "streams of the Pacific slope" as its habitat; the Museum of California Academy of Science has a specimen from the Pajaro River, and Mr. Livingston Stone states that it occurs in Clear Lake. This species belongs to the *Centrarchidae*, a group which includes the numerous species of "sun-fishes," or "pond fishes," numbering altogether (according to Professor Jordan) sixteen genera and sixty species. The headquarters of this family is in the Mississippi Valley, and the present is the only species known in California. The *Serranoid* fish, previously alluded to, is *Stereolepis gigas*, Ayres, more commonly called the Jew-fish. Monterey Bay appears to be the most northern point ordinarily frequented by this fish, which attains the immense weight of from four to five hundred pounds, and is a most delicious food fish—superior, as I am assured by those who have tasted it, to any of the rock-fishes. Very rarely it has been taken in San Francisco Bay. The range of this species extends to New Zealand.

THE ROCK-COD OR ROCK-FISH.

Under these names are included the various species of *Chirus*, *Sebastichthys*, *Sebastodes*, *Ophiodon*, and *Scorpenichthys*, many of which are caught within the bay, others at various points along the coast, especially towards the north.

The genera enumerated belong to the old family *Triglidae* or *Selerogenidae*, the latter name meaning "mailed cheeks," and referring to the extension backwards of the suborbitals and their union with the preopercula. On account of the considerable structural differences which distinguished the sections or sub-families of this large family, it is now usually divided into several distinct families, and our rock-

fish belong to three of these, namely: *Chirus* and *Ophiodon* to the *Chiridae*, *Sebastichthys*, and *Sebastodes* to the *Scorpenidae* and *Scorpenichthys* to the *Cottidae* or Sculpins. The members of the genus *Chirus* may be readily distinguished from the others by their comparative smoothness, and the presence of several lateral lines of pores. *Sebastichthys* and *Sebastodes* have an armature of spines upon the top of the head and the edge of the preoperculum, and thirteen spines in the dorsal fin; *Ophiodon* has small scales, a smooth head, a scarcely spinous preoperculum, and twenty-six dorsal spines; while *Scorpenichthys*, like most of the species of the family *Cottidae*, is scaleless and has a depressed head with various spines and flaps. The flesh of these fishes is firm and nutritious, but rather dry, lacking the delicacy of some of the *Pleuronectidae* and the richness of the salmon.

Several of these species were described by Dr. Ayres, in the Proceedings of the California Academy of Science, volumes 1 and 2; and although, in some cases, his notes are antedated by those of Girard Pacific Railroad Report, volume 10, the Californian naturalist may still claim to be the first to introduce six of them to the scientific world. Two species observed by Dr. Ayres I have not yet observed in the markets; these are *Sebastichthys elongatus* and *Sebastichthys ovalis*. The first I am acquainted with only by the specimens in the Museum of the California Academy of Science; the second I have not yet recognized.

CHIRIDÆ.

All the fishes of this family have small scales, ctenoid or cycloid, a long, continuous dorsal, or two dorsals, and an elongated, rather compressed form. The head is spineless. Exclusively marine.

Chirus constellatus, Girard, Constellated; *Chirus guttatus*, Girard, Spotted—The fishes of this genus appear in the market in greater or less abundance throughout the whole of the winter, spring and summer. They are usually taken in the bay. Many of the fishermen and dealers call these fishes sea trout; others do not distinguish them from the various species of *Sebastichthys*—the names of rock-fish or rock-cod serving alike for all. *Constellatus* may be known by the more or less perfect circles of small round spots, inclosing a lighter area, that diversify its sides, while *C. guttatus* is covered with small yellow blotches, sometimes arranged in irregular rows. These light blotches become darker on exposure to the air. *Constellatus* may also be distinguished by the spotted pectoral fin. *C. pictus*, the painted sea trout, is not so often seen as the two previously mentioned, although it is taken in the bay. *C. nebulosus* is also sometimes brought to market, as the Academy of Sciences possesses a specimen bought there. *C. pictus* may be identified by the rich reddish-brown spots and blue cloudings upon its sides, and by the pectorals, alternately barred light and dark. *C. nebulosus* is dark above, lighter below, the two colors showing a tendency to form bands on the sides. All these fishes are peculiar in having several lateral lines along the sides instead of one, as is usual among fishes. The length of full-grown individuals is from twelve to sixteen inches.

Ophiodon elongatus, Girard, Green Rock-cod—This is one of the largest and commonest of our marketable fishes, attaining a length of over three or even four feet, and is usually in great part of a lively green color, spotted or clouded with light brown. But the

coloration of the adults varies greatly. The brown markings sometimes cover almost the entire fish, and different shades of brown occur in the same individual. The young is spotted with round spots of a light yellowish-brown, and it was to the young that the name *Ophiodon elongatus* was originally given by Girard, who described the adult with the title of *Oplopoma pantherina*. *Ophiodon elongatus* was said to have a continuous dorsal, with twenty-seven spines and no membranous flap upon the forehead, while *Oplopoma pantherina* was characterized by two separate dorsals, the first with twenty-five spines, and by the presence of a membranous flap. Dr. Steindachner corrects this error (*Ichthyologische Beiträge*, No. III.), and proves that the continuous dorsal and membranous flap are characters of the species.

The correct number of spines is twenty-seven, but the adult frequently comes to market in a dilapidated condition, with the spines torn apart from each other, or even broken away, and it is most probable that Girard described his *Oplopoma pantherina* from such a mutilated specimen. Young and half-grown individuals are common in the Bay of San Francisco, but the larger examples are taken in tolerably deep water, outside of the bay, especially in the vicinity of the Farallones. Steindachner gives the range of this species as from Sitka to Monterey. This is a highly carnivorous fish. The fishermen describe it as the terror of the inhabitants of the rocks; the other fishes hide for fear of it, and are often seized off the hooks by it.

Another *chiroid*, not usually called a rock-fish, is *Anoplopoma fimbria*, a species which, though rare in our markets, except in September and October, is of more common occurrence northwards, and occurs also along the northern coast of eastern Asiatic Russia. Examples sold here seldom reach a length of more than twelve or occasionally sixteen inches.

SCORPÆNIDÆ.

The sea-scorpions are easily recognized by their etenoid scales, spinous heads and gill-covers, and single dorsal fin. The union of the dorsals and the presence of true scales, always spinous on their free margins, distinguishes this family from the *Cottidæ*; while the larger head, the armature of spines, the usually stouter body and the rougher scales, distinguish it from the *Chiridæ*. Exclusively marine; of wide distribution.

Sebastichthys flavidus, Ayres, Gill, Yellow Rock-cod—This is one of the most abundant of the rock-fishes, equaling in this respect *ruber* and *pinniger*. It may be known by the greenish-brown and yellowish-green tints of the back and sides, as well as by the third anal spine, which exceeds the second in length, instead of only equaling it, as in *Sebastichthys melanops*. The spines upon the top of the head are not large. In size it equals *Sebastichthys melanops*. Those brought to market are taken outside the bay.

Sebastichthys pinniger, Gill, Smooth Red Rock-cod—This species was first noticed by Ayres (Proceedings California Academy of Science, 11, 1862, p. 207), but was, by that ichthyologist, wrongly identified with the *Sebastichthys rosaceus* of Girard. It became, therefore, necessary to rename it.

Sebastichthys pinniger appears to attain a larger size than any of the other nearly related rock-fish, except *Sebastichthys ruber*, which it usually equals in length but not in weight, as it is of more slender

proportions. In weight it seldom, if ever, exceeds fourteen pounds. It is not taken within the bay. In color it is far from uniform, the upper portion of the head and back being blotched with a darker red than the ground tint, inclining to brown. The spines upon the upper surface of the head are small and inconspicuous, and the paired fins long, the ventrals extending beyond the vent, and the pectorals to within four scales of the first anal spine.

Sebastichthys melanops, Girard, Black Rock-cod—This fish does not usually attain so large a size as *Sebastichthys ruber* or *Sebastichthys rosaceus*. It is one of the commonest kinds of rock-fish, occurring in the markets almost every day throughout the year. The back of this fish is almost black, inclining to purple, the fins are dark purple, and the sides blotched with purplish black. Besides those taken in the immediate neighborhood of San Francisco, large quantities are sent from Monterey and other localities.

Sebastichthys rosaceus, Girard, Pink-spotted Rock-fish—The species thus named is not the *rosaceus* of Dr. Ayres, who identified Girard's *rosaceus* with what has been proved to be a new species, the *Sebastichthys pinniger* of Gill; but it is identical with the *Sebastes helvomaculatus* of the former naturalist. It is smaller even than *Sebastichthys nebulosus*, not equaling it in length and of much more slender form. The three elongated pink spots along each side are constant, and at once distinguish it from every other species. In color it resembles *Sebastichthys ruber*. Though not so common as *Sebastichthys auriculatus* or *Sebastichthys melanops*, or even as *Sebastichthys nebulosus*, *Sebastichthys ruber*, or *Sebastichthys pinniger*; it is brought in in considerable numbers. In length it very seldom exceeds twelve inches. It is probable that this species is identical with *S. oculatus*, Val.

Sebastichthys nigrocinctus, Black-banded Rock-cod—This species is reddish-yellow, with five or six nearly vertical, broad, cross bands, and usually two or three short bands radiating from the eye; but these bands are much more developed in some specimens than in others. It is one of the rarest of our edible fishes, as only single individuals are brought to the market at considerable intervals of time. It is not taken inside the bay. In size it is about equal to *Sebastichthys melanops* or *Sebastichthys flavidus*. There is no mistaking this fish, with its conspicuous black bands across a reddish ground, for any other fish in our markets.

Sebastichthys ruber, Ayres, Rough Red Rock-cod.—This, the largest of the genus occurring in our waters, is stated to reach, though rarely, a weight of twenty-five pounds. It is of a uniform bright red, very different from the brownish red mingled with orange red which forms the livery of *Sebastichthys pinniger*. In form it is stouter than *Sebastichthys pinniger* but less so than *Sebastichthys nebulosus*. It is usually taken outside of the bay, usually from deep water around the Farrallone Islands. It occurs also northward at least as far as Humboldt Bay. By the uniformity of the color, the abundance of supernumerary scales on the large scales, and the peculiar shape of the preopercular spines, this species may readily be distinguished from *Sebastichthys pinniger* as well as from *Sebastichthys rosaceus*, the latter of which strongly resembles it at first sight. The three pink spots of *rosaceus* are, however, a constant character by which it may be known from young individuals of *Sebastichthys ruber*; and the

smooth surface of the head in *Sebastichthys pinniger* distinguishes it as readily from the same species.

Sebastichthys auriculatus, Girard, Black-shouldered Rock-cod—This is rather a small species, seldom exceeding eighteen inches in length, and is brought to the markets in great abundance, probably on account of its common occurrence in the bay. Not only does this species occur, together with two or three others of the smaller kinds of *Sebastichthys*, and the young of the larger kinds, in the deeper portions of the bay near the entrance, but it is also abundant along the eastern shore of the bay where no other species of the genus is found, probably on account of the admixture of fresh water from the Sacramento River. This fish can always be distinguished by a black mark upon each of the gill-covers, very obvious in the younger fish, and sufficiently distinct, though less clearly outlined, in older specimens. The general color is a dull reddish brown with cloudings of a darker tint upon the back and sides; these cloudings, like the black spot before mentioned, becoming more diffused and indistinct with increasing size and age. This is another of the kinds which must eventually become scarcer, unless some means be taken to prevent waste. Small individuals, four to six inches long, are brought to market in great numbers from various parts of the bay.

The lower jaw in *Sebastichthys auriculatus* projects but slightly, contrasting broadly with that of *flavidus*, and most of the other species of the genus.

Sebastichthys nebulosus, Ayres, Clouded Rock-cod—This is one of the smallest of our rock-fish, yet is heavier by far than individuals of other species of equal length, on account of the stoutness of its form. It seldom attains a length of more than eleven or twelve inches, though it occasionally reaches eighteen inches, and seven pounds is the greatest weight ever attributed to it. Some of the specimens have a broad yellow band along each side, and are also adorned with yellow blotches of variable form and size; but in others this band, which doubtless suggested to Girard his name of *fasciatus*, is absent, and the dark and light tints of the sides are mingled together without any approach to regularity or beauty. In this species the lower jaw does not project as in most of its tribe, but is even with the upper. It is one of the most abundant of the rock-fish.

Sebastodes paucispinis, Girard, Gill, Small-scaled Rock-fish—This species may readily be distinguished from all the species of *Sebastichthys* by the smaller size of the scales, as well as by the straight dorsal outline and the extreme elongation of the lower jaw, the tip of which extends upwards to the line at the top of the head, and forms part of its upper outline. The spines upon the head are very little developed. This is one of the rarest of our food fishes, occurring in our markets only at considerable intervals, and in small numbers. In color it is reddish brown on the back, as well as on the dorsal and caudal fins; the tint becoming lighter but more decidedly red on the sides and abdomen. In size it exceeds many of its relations, as most of those brought to market reach or exceed two feet in length.

COTTIDÆ.

Spinous dorsal shorter than the soft dorsals, separate body without true scales, but often with prickles or scale-like plates.

Scorpanichthys marmoratus, Girard, Large Red Sculpin, or Bull-head—Despite the absence of scales upon its body, this species is commonly styled a rock-cod. While its nearest relations, the smaller sculpins, or catfish, as they are often called here, are thrown away by the fishermen, this large sculpin is allowed a place among our food fishes. *A priori* one would expect the other sculpins to be good food, and I am assured by those who have tried them that they are; all they need is skinning before cooking. Although tolerably common within the Bay of San Francisco, and very frequently taken by the angling fraternity upon Oakland wharf and in similar situations, this species is only occasionally brought to market, and then only in small quantities.

Under the name of *Hemitripterus marmoratus*, this species was described by Dr. Ayres, in the Proceedings of California Academy of Sciences, vol. 1, p. 4.

Scorpanichthys marmoratus is sometimes called a rock-cod, at others a bull-head; the latter name being also applied to other *cottoids* with depressed heads. It reaches a length of two feet or more. Several smaller *cottoids* are brought to market occasionally, more by accident than design. These are *Hemilepidotus spinosus*, a species with four bands of scales; *Leptocottus armatus*, the common yellow sculpin of the Bay of San Francisco, *Aspicottus bison*, *Artedius lateralis*, *Artedius pugettensis*, and a species, probably new to science, which I have described under the name of *Artedius quadriseriatus*. None of these are used to any extent as food, yet *Leptocottus armatus* is sufficiently common in this bay to be so used, if the prejudice against its appearance could be conquered.

SCIENIDÆ.

In this family the body is compressed and rather elongated; dorsal fins, two sometimes slightly connected, the first consisting of not very strong spines, and less developed than the second, or soft dorsal; teeth of the jaws in villiform bands, none on the vomer, or palate; scales etenoid, but not very strongly so. Other characters are a continuous lateral line, generally one or two anal spines; the presence in most cases of barbels, or pores, under the chin; bones of skull more or less cavernous; and usually a large air bladder. Chiefly marine.

Atractoscion nobilis, Ayres, Gill, Sea Bass—This is one of the most valuable of our food fishes, since it grows to a large size, and is of most excellent flavor. Its usual dimensions are those of an ordinary salmon, but it frequently attains a larger size, a large individual reaching a weight of seventy or even ninety-five pounds, and a length of five feet. It is taken in the bay, and at various points along the coast, north and south. Ayres states that Captain Scammon found it abundant as far south as latitude 27°. In our markets it is sometimes plentiful, but the supply is very uncertain, even when it is in season. During the months of November, December, and January, to February 20th, I did not meet with a single individual, but in October, and from March to September, it has been of tolerably frequent occurrence. "Sea Bass," boiled and baked, is a constant dish at the restaurants of the city, but examination shows that much of that sold at the cheaper restaurants is sturgeon. In color, it is of a clear grayish blue, with metallic blue and golden reflections on the

fore part of the body, and on the head, when fresh; the sides are lighter. The first dorsal fin has ten spines; the second, one spine, and twenty-two articulated rays.

Genyanemus lineatus, Gill; *Leiostomus lineatus*, Ayres; the King-fish—This species was formerly common in the bay, but since its waters have been defiled with so much tar and drain refuse by our destructive imperfect civilization it has become scarce, and is now usually obtained outside. It is, in my opinion, one of the most delicate of our food fishes, and, fortunately, is still abundant, occurring in greater or less numbers in our markets throughout the year. In size it does not greatly exceed a herring, average individuals measuring six to eight inches in length. Ayres says "it seldom exceeds eleven inches." Other names for this species are little basse and coguard. The wavy lines of browner tint which run obliquely along the grayish-brown body are in many specimens not very obvious. By these bars and the obtuse snout, under which the lower jaw is received, this species may readily be known from the next.

Seriophus politus, King-fish.—This fish, known by the dealers by the same name as the last, but readily distinguishable from it by its longer head, much longer lower jaw, shorter spinous dorsal and more silvery tint, scarcely deserves, on account of its rarity, to be mentioned among our food fishes, yet is taken within the Bay of San Francisco. I have never seen more than one or two in the market at once.

LABRIDÆ.

This is the leading family of a group which, in consequence of the coalescence of the two lower pharyngeal bones into a single tooth-bearing bone, has received the name of *Pharyngognathi*, and has been by many naturalists raised to the rank of an order. As, however, examples of the union of the pharyngeal bones may be found among fishes differing widely from each other in other structural points, this single character is not now usually believed to be of ordinal value; yet the *Labridæ*, the *Embiotocidæ* and several other families nearly united in other respects, form a natural super-family or section of an order. The *Labridæ*, as their name indicates, are characterized by having the lips, which in most fishes are thin and inconspicuous, well developed and thick. The scales are large and cycloid; a lateral line is present, but in most cases is interrupted in its course, and the spinous dorsal varies considerably in its development.

This family is sparsely represented on our coast. *Pimelometopon pulcher*, Gill, *Labrus pulcher*, Ayres, is occasionally brought to market in the autumnal months from more southern points, but is rare. It attains a length of over two feet, and may at once be recognized by its conspicuous livery of black and red, the former occupying the head as far as the pectorals, as well as the posterior portion of the body, the latter a broad transverse band from the pectorals to behind the anal. The pectorals, ventrals, caudal and dorsal are black. *Oxyjulis modestus*, Girard, Gill, a smaller species, is of still rarer occurrence, but becomes commoner in the more southern parts of the State.

EMBIOTOCIDÆ.

Ever since the first discovery of these fishes they have been objects of great interest to ichthyologists, chiefly on account of their peculiar method of reproduction. While by far the greater number of the true fishes are simply oviparous, that is, deposit their fully formed ova upon the bottom of the river or sea which they inhabit, some few are ovo-viviparous, the eggs being retained in the interior of the ovary and hatched there. Prominent among these is the well known

Zoarces anguillaris, or viviparous blenny; but in the *Embiotocidae* we have a family of considerable size, all the members of which bring forth their young alive and fully formed. The interior of each ovary is divided by highly vascular membranes into longitudinal compartments, in which the young are systematically arranged; and no better idea of the appearance of an ovary thus packed with living young can be formed than by comparing it with the interior of a pomegranate, the pips representing the young, and the partitions those dividing the ovaries. Only it must be remembered that there are of course no transverse partitions in the ovary of an embiotocoid, as in that case there would be no means of exit. The appearance, however, is similar to that of the fruit, as the longitudinal membranes form a fold between each embryo. Between the ventral fins and the vulva there is a scaleless space upon the abdomen, forming a sort of sheath or fold, usually concealed by the projection of the scales of the sides. The shape of these fishes is not unlike that of the sunfishes or pond perch (*Centrarchidae*), or of the sheep's head and porgee of the Atlantic; but the scales are cycloid or smooth, and rather large; the lips well developed (in some cases excessively thick), and the mouth very extensible, characters which prove a rather near relationship to the *Labridae* or Wrasse family. The cheeks are scaly, and a narrow sheath of scales extends along the base of the soft dorsal. During the winter months the supply of these fishes was comparatively small, and chiefly confined to the kinds which inhabit the bay, but during April and May the supply has been very abundant, the species constituting the bulk of the catch being *Embiotoca jacksoni*, *Embiotoca lateralis*, *Hypsurus caryi*, *Holconotus rhodoterus*, *Phanerodon furcatus*, *Rhacochilus toxotes*, *Damalichthys vacca*, and *Hyperprosopon argenteus*. Most of those brought to market are females, full of young, and it is safe to say that at least twenty perfectly formed young fishes are killed for every adult taken at this season. The greater part of the spring supply comes from the north of our bay, near Tomales Bay; and some of the kinds found in our own bay all the year round are not largely represented. Among these are *Amphistichus argenteus*, *Cymatogaster (Micrometrus) aggregatus*, and *Abuconia minima*, the latter the "shiner" of the angling fraternity, and the only one of the marine species of the group which is too small to be of much value for food. As the habits of this tribe of fishes are not well known, I will only suggest the desirability, for the sake of ensuring the permanence of the supply of a group which is only second to the salmon in its importance as an article of food for the people of this coast, of some legislative regulations which may give the females a chance to perpetuate their race before they are taken. How to do this I do not venture to say, as I do not know whether many of the species are procurable at any other than the season of reproduction, and I here ask all who have leisure to investigate the matter, to endeavor to ascertain at what season the various species of this tribe seek the shallower water, and whether they are to be found at other seasons in such localities that they can be taken.

Unless some means is found of protecting some of the more useful and abundant of our fishes, so that they may have a chance to reproduce their kind; our supply of fish, even now too limited for the demand, will, in a few years, dwindle to next to nothing. Our bay will be "fished out" as many a river and bay in Europe has been

fished out, and one of our most important sources of food supply will be dried up. The peculiar mode of reproduction of these fishes not only render them of considerable scientific interest, but the young, hatched perfectly formed, and able to take care of themselves from the moment of their exclusion from the oviduct, have many more chances in the struggle for life than those of ordinary fishes; and with a little care on our part it is probable that an abundant supply could be maintained. We take the ova of the shad and the salmon, and by careful watching and tending hatch the young, which we then put into the rivers to take their chance; but in this tribe of fishes nature does all this work for us, and all we have to do is to let the young fish get away safely, as far as we are concerned.

I have mentioned by name eleven species, but these are not all. About eighteen kinds are known, one of them a native of Japan, the others all from this coast; one, *Hysteroecarpus traskii*, Gibbons, is found in the fresh waters of our State, but all the others are marine.

The Embiotocidæ are a difficult family to study, not only because of the anatomical peculiarities which need fuller investigation, but on account of the confusion into which the nomenclature has fallen. Various species were, about 1854, described almost simultaneously by Agassiz and by Dr. W. P. Gibbons, of Alameda. Shortly after, Girard, in the Pacific Railroad Report, described several species, most of them identical with those described by the two former naturalists. Each of these writers gave a different name to the same species; this was unavoidable in the case of the first two naturalists. But Girard, coming after the others, chose also to re-describe them giving at the end of his work on the family a list of Dr. Gibbons' species which he states he could not recognize. He who undertakes to write scientifically upon this group has now to disentangle the maze of synonymy, and also to determine which of the numerous genera have characters which entitle them to recognition, and all this means a great deal of hard and unattractive work.

These fishes are commonly known as "perch," although some of the species have been honored with distinctive titles.

Embiotoca jacksoni, Agassiz, the Pogy or Black Basse—The pogy, black basse, or black perch, as it is variously called, on account of a supposed resemblance to fishes not very nearly related, is perhaps the best known of the family. At the same time it is one of the most difficult to distinguish, on account of the difference of color between the male and female, and between the young and the adult. Thus the *Embiotoca cassidii* and *Embiotoca webbi* of Girard are only partially grown black perch. The female is of a deep dark purplish-brown, with the vertical fins and ventrals of a bluer purple; but the male is much lighter in tint. The young have transverse bands across the body, a peculiarity which is common to the young of the whole family, but persists in the adults of some species. These bands are in all cases darker than the ground tint. Some individuals have the vertical fins decidedly violet. There are four rows of scales upon the cheek. Girard gives the number of young in the two ovaries as about sixty. This species is tolerably common in the Bay of San Francisco, and abounds in Tomales Bay; and is brought to market more or less abundantly throughout the year. It is one of the largest of the family, attaining a length of fourteen or fifteen inches, and a weight of from three to four pounds.

Teniotoca lateralis, Agassiz, Blue-banded Perch—By the peculiarity

embodied in the English name I have ventured to apply to it, this fish may at once be known from the other species of the family. The sides are banded with numerous longitudinal stripes of purple, and the head is adorned with various bluish marks. Like *Embiotoca jacksoni*, it is found both in San Francisco and Tomales Bays. It attains very nearly as large a size as the former species, and it is brought to our markets at all seasons of the year, though less abundantly in the winter than in April and May. As in the last species, the young differ in their coloration from the adult, being usually lighter and more brightly colored, and this has been the cause of the description of nominal species.

Hypsurus Caryi, Agassiz, the Orange-banded Perch—This, one of the most beautifully tinted of the family, is either not found in this bay or is very rare there, as only occasional specimens occurred in the markets during the winter months. Large quantities of this species have been brought from Tomales and its vicinity during the months of April and May; it is not a large form, exceeding in this respect the species of *Hyperprosopon*, but falling far behind either of the previously mentioned kinds. The largest I have seen was not more than twelve inches long, and the average length is about ten inches. It may be at once recognized both by its coloration and by its form. The species most nearly resembling it in color is *Embiotoca lateralis*, but in the present species the blue streaks are mingled with orange, which latter tint predominates upon the abdomen, the back is richly bronzed; the dorsal, caudal, and anal are irregularly banded with orange and white; the pectorals are of light golden; there is a black blotch on the anterior part of the anal, and the ventrals are tipped with black. But the form of the body is still more distinctive. The anal fin is formed of fewer rays than in the preceding species, and these rays are crowded into a short space and directed horizontally backwards, their base being directed upwards at an angle of about 60° from the horizontal. The space between the ventrals and anal is thus longer than in the other *Embiotocidæ*, this, together with the short, horizontally, directed anal, and the straight line formed by the abdominal outline, give the fish a peculiar appearance. The teeth are few, four to six in the upper and nine to twelve in the lower jaw. All the examples I have seen in May were females with their ovaries full of young.

Phanerodon furcatus, Girard—Extremely abundant in the markets during the summer and autumn, the supply coming from Tomales Bay. This is one of the most uniformly colored of the *Embiotocidæ*, the prevailing tint being that of burnished silver. The older individuals are darker above, and the dorsal and caudal have a darker margin. The dorsal spines increase in length to the last, which is almost as long as the first ray; the anal is long and low, and the caudal peduncle narrow. *Phanerodon furcatus* seldom reaches a length of more than twelve inches, and as it is a slender and rather thin species, its weight seldom exceeds one pound.

Damalichthys vacca, Girard—In general form this species closely resembles the thick-lipped perch, but may at once be distinguished from it by the want of the thick lips. I first noticed its presence in the markets in the month of February, and from that time to October it has been tolerably abundant. Most of those I have seen were about a foot in total length and about four inches in width across the body; but the species attains a weight of from three to four

pounds. In color it is slaty-gray, becoming more silvery on the sides and silvery-white below, without any conspicuous marks or bands. The second ray of the soft dorsal is twice the height of the last and highest spine of the spinous portion of the same fin.

Rhacochilus toxotes, Agassiz, Thick-lipped Perch—This is the finest and largest of the tribe, attaining a length of sixteen or eighteen inches, and a weight of from five to six pounds. It can be at once identified by the great thickness and prominence of its lips, especially the lower lip, which forms a broad, continuous fold around the lower jaw. The greatest width is about a third of the total length. The caudal peduncle is long and the spinous portion of the dorsal fin much lower than the soft portion. The teeth are few, and in a single row. The coloration of the fresh fish is not conspicuous, as it is chiefly a bright silvery-gray, becoming darker and metallic on the back, with a reddish tinge posteriorly, and dark and dull on the top of the head. From April to September this species has been of tolerably common occurrence in the markets, though by no means so abundant as *lateralis*, *caryi* or *Hyperprosopon argenteus*. It is usually sold at a higher price than the other perch. Those brought to market in the months named are caught in Tomales Bay.

Micrometrus aggregatus, Agassiz; *Cymatogaster aggregatus*, Gibbons, Large Shiner—This is one of the kinds ordinarily found in San Francisco Bay, brought to market, though not in abundance, throughout the year, and frequently taken by anglers. It does not attain the dimensions of the *Embiotoca jacksoni*, *Embiotoca lateralis*, or *Rhacochilus toxotes*. The scales of this species are comparatively large, the lateral line containing only from forty to forty-four. The longest spines are longer than the rays of the soft dorsal, and the sides have eight or nine longitudinal bands, formed of black dots. The young have three or four vertical bands.

A still smaller species is the *Micrometrus minimus* of Gibbons, *Abeona trowbridgii* of Girard, and Shiner of the small boys, who usually contemptuously fling it back into the bay whenever they take it. Its presence in the market is only accidental, among the heaps of small flat-fishes or smelts.

Hyperprosopon argenteus, Gibbons, Large-eyed Perch—The large eye; the upward turned mouth; the lower jaw extending to, or even beyond, the horizontal from the upper margin of the pupil; the broad short body, the shape of the spinous dorsal, the fourth spine of which is the longest, and longer than the soft dorsal; the silvery color, and the black-tipped ventrals, render this easily recognizable from all the other *Embiotocidæ* except the rarer *Hyperprosopon agassizii*, *Hyperprosopon arcuatus*, and *Hypercritichthys analis*. The first of these is known by the absence of the black tips to the ventrals, and the presence of a black margin to the caudal; the second by the greater curve of the back, less depressed forehead, smaller eyes, and shorter lower jaw; and the third by the considerably smaller eye, more elongate body, shorter dorsal and anal, and the presence of a black spot in the middle of the caudal. The large-eyed perch is common in San Francisco Bay, and during the months of April and May is brought in large quantities from Tomales Bay. It is smaller than most of the preceding species, the length seldom exceeding nine or ten inches, and the weight about half a pound.

In this genus the teeth form a single row extending all around the lower jaw, and about half way along the upper, thus differing from

Embiotoca, *Hypsurus*, and *Rhacochilus*, which have only a few teeth in each jaw, and from *Micrometrus* and *Amphistichus*, which have a double row.

The present species, together with *Hyperprosopon agassizii* and *Hyperprosopon arcuatus*, differ considerably in form from the rest of the family, as the greatest width is contained in the total length to the tip of the caudal only two and a half times.

All these brought to market in May, so far as I have observed, are females, with the ovaries full of young; but this species is taken at all seasons of the year.

Holconotus rhodotercus, Agassiz, Red-fin Perch—This is another of the kinds which inhabit the Bay of San Francisco. It may be readily identified by the reddish color of the fins, while the shape of the spinous dorsal, which is highest in the middle, differs from that of all the other *Embiotocidæ* except those belonging to the genus *Hyperprosopon*, from which the smaller eye and more elongate form at once distinguishes it.

As is the case with most of the species of *Embiotocidæ*, the supply of this fish is very irregular. After weeks during which it either does not occur or is very rare, it will suddenly appear in the market in great abundance, forming a large proportion of the total catch of perch.

Amphistichus argenteus, Agassiz, Silver Perch—This is another of the species common in the bay. From *Micrometrus aggregatus* it may be known by its much smaller scales, and by the persistence, in the adult, of transverse bands upon the body; and from *Hyperprosopon argenteus* by its smaller eye and more elongated form; and from *Holconotus rhodotercus* by the lower spinous dorsal. In length it seldom exceeds ten or twelve inches, and the largest individuals attain a weight of two pounds or a little more. The fifth dorsal spine is slightly longer than the last, which is a little shorter than the anterior articulated rays.

SPHYRÆNIDÆ.

Sphyræna argentea, Girard, the Barracuda—It is well not to be misled by English names. That of barracuda is applied not only to all the species of *Sphyræna*, of which there are several, but also to fishes of other families, and even other orders. In the rivers of South America the name is given to the *Sudis* (*Arapaima*) *gigas*, a soft finned, large scaled, fresh water, carnivorous fish. All barracudas, however, are fierce, rapacious fishes, and the one we are at present considering attains a length of over three feet, and a weight of from twelve to fourteen pounds. The form is slender, but it is nearly as thick as it is deep, and its jaws are armed with a formidable row of sharp teeth. When darting through the water it looks like a silver arrow. It is usually obtained south of the bay, and at the Farallones, but occurs at least as far north as Tomales. Its flesh is very good eating, so that if it devours our food fishes we may console ourselves by devouring it.

I am informed that this fish has never been known to occur in the bay. This fish may at once be recognized by its long, cylindrical shape, elongate head, cycloid or smooth scales; first dorsal fin of five spines only, the second spine highest, and second dorsal, of eleven rays, placed far behind the first dorsal. This species is the only rep-

representative on this coast of the family *Sphyrænidæ*, which consists of the single genus *Sphyrna*.

SCOMBRIDÆ.

The five following species belong to this family, as defined by the older writers, including the *Stromateidæ*, *Carangidæ*, and other tribes not represented here. None of them are caught, except rarely, near San Francisco, and most are highly prized, both on account of their rarity and their quality. In all the scales are very small and smooth, or are absent; the color is steely blue, lighter below, and the caudal is broadly bilobate. The three first noticed are true *Scombridæ*, and have several small finlets behind the dorsal and anal fins.

Scomber colias, Spanish Mackerel—The *Scomber diego* described by Ayres (Proceedings California Academy of Science, vol. 1, 1857, p. 92) has been proved by Steindachner to be identical with the long known *Scomber colias* or Spanish mackerel of the European seas. Steindachner states that it occurs frequently on the coast of the Galapagos Islands, and wanders in small shoals along the Californian coast as far as San Diego, also that single individuals occur near San Francisco. Thus this species and *Albula vulpes* are among the few fishes which inhabit both the Atlantic and the Pacific Oceans. On one occasion only, in April of the present year, I found this species in the market in tolerable abundance, and it has again occurred in September. Those which were then exposed for sale were small, not above eight inches long, and came from Monterey Bay. The identity of Ayres' *Scomber diego* with *Scomber colias* has been confirmed by a comparison of Ayres' original specimen with the diagnosis given by Günther. (Catalogue of Fishes, British Museum, II).

From the two succeeding species this may be readily known by the presence of only five finlets behind the dorsal and anal fins; by the spinous dorsal of seven spines; and by the irregular reticulated dark lines upon the back.

Sarda lineolata, Girard—This, like all the Pacific Coast Scombride, is not very often brought to the markets of San Francisco, except in September and October. They are usually caught in Monterey Bay.

Günther (Cat-fish, British Museum, II, 368) considers this species to be identical with the *Pelamys chilensis* of Cuv. and Val. It attains a considerable size, a series of four specimens lying on the stalls measuring respectively two feet, two and a quarter inches; two feet, two and three-quarter inches; and two feet, three and a half inches, from tip of snout to fork of caudal fin. The caudal fin cannot be said to be crescentic, as stated by Girard, since its posterior margin form two sides of an obtuse isosceles triangle. The sides and belly are silvery, becoming bluish-black towards and on the back, and five or six obliquely longitudinal bands of the darker tint run along the sides.

From November to the end of May this species has not occurred in the markets. Appearances indicate that this and some other *Scomberoids* take a run northwards in the autumn, and thus reach the San Francisco markets from Monterey. The patch of larger scales behind the pectoral fin, and the oblique, darker streaks upon the sides of the body, serve to distinguish this species from the succeeding one, but the dealers distinguish them also by the texture of the flesh, which is softer in this species than in *Chromitra concolor*. The first dorsal has eighteen spines, and there are eight finlets behind the dorsal, and seven behind the anal.

Chromitra concolor, Lockington—In October and November of the past year, my attention was drawn to a *Scomberoid* which somewhat resembled the *Pelamys* (*Sarda*) *lineolata* of Girard, but examination proved not only that it was not that species but that, on account of the absence of a corselet, or patch of large scales behind the pectoral fin, and the want of teeth on the vomer, or palatines, it must be made the type of a distinct genus.

Very few of these fishes were brought in during the autumn—by no means sufficient to supply the demand, for it is in great repute among rich gastronomists, and fetches a high price. Its flesh is said to be far firmer and better than that of *Sarda lineolata*, from which it may be readily distinguished by the characters mentioned above, but also by the absence of the darker, oblique streaks which diversify the flanks of the latter fish. Although most of the individuals sold here are brought from Monterey, I am informed that stragglers have been caught as far north as Tomales. Those which I have seen have averaged about two feet in total length to the tip of the caudal lobes. There are seven or eight finlets behind the dorsal, and eight behind the anal fin. There are seldom more than two or three of this species in the markets at once.

Poronotus simillimus, Ayres, Pompino—This species was first described by Dr. Ayres (Proceedings California Academy, vol. 2., page 84, figure on page 85) in December, 1860, and accompanied by a tolerable outline figure. Dr. Ayres states that in the course of seven years he only saw three or four specimens; but this year at least it is far more abundant, as I have seen as many as thirty or forty on the same stall on many occasions. As with the other *Scomberoids*, the examples brought to this market are usually caught in Monterey Bay, which appears to form the northern limit of many species of fishes, crustacea, and echinoderms. The Italian fishermen call this species “pompino,” and this must be accepted, in the absence of any other, as its English name. I am informed that a fish called “pompino,” on the Atlantic coast, is considered to be the most delicate of all fishes. This is *Trachynotus carolinus*, a very different species. Our “pompino” is also highly prized as a delicate morsel, and is one of the dearest fishes in the market. This species has been more or less abundant throughout the whole of the winter and spring, but during part of the time the catch has been principally composed of very small individuals, not above three or four inches long, which certainly should not have been caught at all. Most of these small ones are, if I have been rightly informed, taken in the Bay of San Francisco, to which this species is an occasional visitant, and the high price the species commands tempts the fishermen to catch all they can find. An adult pompino measures from eight to ten inches in length. This fish may be identified at once by the total absence of ventral fins, while its thin, broad, oval body, bright steely color, and dorsal fin with only a single spine, are other conspicuous features. It is covered with rather small, smooth scales.

Trachurus symmetricus, Ayres, Horse-mackerel—Authorities differ as to whether this fish is peculiar to this coast or is identical with the *Trachurus trachurus* of Linnæus. Dr. Günther identifies it with the latter, thus making it identical with the European horse-mackerel, which, if his view is correct, is a widespread form, common to both great oceans. Professor Gill does not agree with this view. He says (Proceedings Academy of Natural Science, Philadelphia, 1862, p.

26): "They can be readily distinguished at first glance. The California species has the flexure (of the lateral line) very abrupt and oblique, and the pectoral fin equal to the length of the head before the preoperculum." This fish is only sent occasionally to our market, usually from Monterey, but when it is present it is in greater abundance than any of the other *Scomberoids*. Occasionally it visits the Bay of San Francisco, for the single specimen (seventeen inches long) on which Dr. Ayres founded his species, was taken there, and the dealers assure me of its occasional occurrence. Those sent from Monterey are seldom as large as Ayres' specimen. It is not valued so highly as either of the previous species. From all the other fishes brought to this market it may be readily known by the series of keeled scales along the center line of the hinder part of the body.

BLENNIIDÆ.

This family, as originally composed, consisted of a heterogeneous assemblage of fishes with little in common except a greater or less tendency to an elongate form, with more or less elongate dorsal and anal fins; and ventrals which are either jugular (in advance of the pectorals) and composed of fewer rays than usual, or are absent altogether. They are, by Professor Gill, divided into several families, among which are the *Anarrhichadidæ* or wolf-fishes; large, ravenous fishes with strong teeth and no ventral fins; *Blenniidæ* or true Blennies, with ventrals and a long, dorsal fin, formed partly of spines, and partly of soft rays; *Stichodæ* or Snake Blennies, with a dorsal composed of spines only, and a compressed, thin body; *Xiphidontidæ* or Gunnels, which differ from the last, among other things, in the absence of a lateral line, and the presence of one ray only, in the ventrals; and *Cryptacanthidæ*, which have the cleft of the mouth nearly vertical, no ventrals, and the dorsal rays all spinous.

To the first of these belongs *Anarrhichthys felis*, Girard, a long snake-like fish, with a large, heavy head—so heavy that if it hang on one side of the hand while the body is on the other, it will draw the body after it—and very strong teeth. It is sometimes brought to market, and attains a length of four to eight feet. The contents of the stomach of a large specimen brought to market, June 10th, consisted entirely of the tests of our common cake-urchin. Another *Blennoid*, occasionally seen in the markets, and reaching a length of more than two feet, is *Cebidichthys cristagalli*, Ayres, a brownish olive fish, with two or three purplish violet bands upon the cheeks, and a crest upon the head (*Cebidichthyidæ*, Gill). The other *Blenniidæ* brought occasionally to market, are quite small fishes, but *Apodichthys flavidus*, Girard, would make up for its small size by its abundance, if it were at all sought for as an article of food. It attains a length of about a foot, and is frequently found under stones above low-water mark.

A species of the *Batrachidæ*, or toad-fishes, *Porichthys porosissimus*, the only one found on the coast, is common in the bay and at various points up the coast, and is sometimes brought to market in the summer, at which season it resorts to the tide-pools under the rocks, to deposit its ova. It attains a length of about sixteen inches, and may be recognized by the lines of silvery pores on the under side of the body, and the absence of scales.

All the above fishes are used as food by the Chinese of San Francisco.

ATHERINIDÆ.

A small family, with two distinct, small dorsal fins, the first composed of five to seven weak spines; ventrals abdominal; teeth feeble; scales smooth; a silvery band along the sides.

Chirostoma californiensis, Girard, Smelt—This species, together with the following, and three species of small Salmonoids mentioned further on, are all sold in the markets and peddled in the streets of San Francisco under the name of smelt. All are taken in the bay, and all are abundant, but the two *Atherinidæ* are far more so in individuals than any of the Salmonoids sold under that name, and exceed them still more in quantity. The present species is much larger than its relation, reaching a length of seventeen inches, and may be distinguished by its larger head, more slender form of body, larger mouth, and the central position of the first or spinous dorsal. It is probably the most common of the fishes of the bay, *Atherinops affinis* alone rivaling it in this respect. Both species are excellent eating, but in this respect are inferior to the salmonoid smelts sold with them. The two *Atherinoids* may be readily distinguished from the salmonoids by the presence of two dorsal fins, the first very small, placed about in the center of the length of the back, and formed of spines of stiff rays, the second rather larger, and separated by an interval from the first. Their prevailing color is light green, but a silvery band runs along each side.

Atherinops affinis, Ayres, Steindachner—In *Atherinops affinis* the dorsal is nearly its own length further back than in *Chirostoma californiensis*, the form of the body is much stouter, the head proportionally smaller, the mouth smaller, the fins larger, and the flesh firmer. Dr. Ayres states that this species never exceeds eight inches in length, and this size must be but rarely attained, as the specimens I have seen in our markets seldom pass six inches, while *A. californiensis* usually exceeds twice that length. Like the last species it is extremely abundant throughout the year. A large proportion of the small fishes wasted by being thrown upon the shore by the fishermen belong to this species; but mingled with them are the young of the last species, quantities of *Engraulis ringens*, and a proportion of true smelts and small flat-fishes. The Chinese dry these small fry in large quantities, on matting spread in the sun, turning and tending them carefully. When dried they are gathered up, trodden down into large sacks, and exported to the Flowery Kingdom. Not only is the mouth proportionally smaller than in the preceding species, but there is only a single row of teeth in the jaws, each tooth two-pointed.

MUGILIDÆ.

Mugil mexicanus (?), Steindachner—Several specimens of a species of *Mugil*, evidently very close to the above species, if not identical with it, have found their way to our markets in the months of September and October. All of them were taken near Santa Cruz, in the Bay of Monterey.

The specimens examined agree with *Mugil mexicanus* in the number of scales in the lateral line, and of rays in the vertical fins; in the length of the latter, in the produced upper caudal lobe, and in the proportions of the body and head. And I should not hesitate to pronounce them to be of that species were it not that Mr. B. B. Redding, one of the Fish Commissioners for the State of California, has

informed me that about three years ago he placed several (I believe about forty) individuals of a *Mugil* from the Sandwich Islands, in the Sacramento River, and it is, therefore, possible that the specimens obtained may be some of these, or their young. I suspect this because the shad introduced from the East finds its way, in considerable numbers, to Monterey Bay, instead of dutifully returning to the place of its birth, and this *Mugil* may have acted in a similar way; also because the specimens agree tolerably well with the diagnosis of *Mugil cephalotus*, given by Günther. The inter-mandibular spaces agrees pretty well with Günther's figure of that of *Mugil cephalotus*, but it is still nearer to Steindachner's figure of *Mugil mexicanus*. As this is a mullet, it is of course tolerably good eating, but it must be remembered that it is not nearly related to those famous delicate fishes, the red mullet and the surmullet, which were so highly prized by the Romans that they fed them in aquaria, but to the gray mullet. The first mentioned fishes belong to the *Mullidæ*, and are provided with a barbel; the latter and our Californian fish to the *Mugilidæ*, which has no barbel and no teeth worth speaking of. From October to the end of May I have only seen a single specimen, which occurred near the end of April.

The *Mugilidæ*, of which this species is the only representative on this coast, are very near to the *Atherinidæ*, forming with that family Gill's suborder *Percesoces*, or perch-pikes. There are two perfectly distinct dorsals, the first of four weak spines; the ventrals are abdominal; the head is broad; the teeth are extremely feeble, or wanting, and there is no silvery longitudinal band.

SUBORDER ANACANTHINI.

In this suborder all the fin rays are soft and articulated; the scales are cycloid; the ventrals jugular, that is, in advance of the pectorals; and the dorsal and anal fins very long, often divided into two or three portions. The suborder includes several families, the most important of which, to the human species, is the *Gadidæ*, to which the cod, haddock, hake, whiting, and other well-known Atlantic fishes belong.

Other families, members of which are found on this coast, and occasionally brought to the markets of this city, are the *Brotulidæ*, *Ophidiidæ*, and *Lycodidæ*, each of which furnishes a single species.

The Ophidioid of our markets is *Ophidium taylori*, Girard, a small fish attaining a length of about ten inches, and inhabiting the sandy beaches at various points along the coast. It is eel-like in form, with continuous vertical fins, a pair of long bifid filaments (representing ventrals) attached to the base of the tongue between the two rami of the lower jaw; and small teeth on jaws, vomer, and palatines.

The Lycodoid, *Lecrurnus paucidens*, Lockington, is still more elongated, but has a much larger mouth and narrower gill openings. Teeth are present upon the jaws only, the ventrals are very small, and the vertical fins continuous.

Both these fishes are excellent as articles of food, and have the additional advantage of the almost entire absence of small bones, but they are not brought to market in sufficient abundance to be of much value.

The Brotuloid is *Brosomphycis marginatus*, Ayres, Gill, a very rare fish, as only two or three specimens occur in the course of a season, but larger than either of the preceding. It may at once be recognized by the continuous margin of red formed by the conjoined dorsal, anal, and caudal fins. Red-fin would be a good English name for it. It attains a length of more than twelve inches, and is less slender than the two preceding species. Of its gastronomical qualities, I cannot speak.

The Gadidæ are represented at this point by the two following species only, as the true cod does not occur so far to the southward.

Merluccius productus, Ayres, Gill, Californian Whiting—Of this species I have as yet seen only a few exceeding fourteen or eighteen inches in length. Dr. Ayres, its first describer, speaks of it as by no means common, but mentions "a few specimens, all taken at the

same time, and from eighteen to twenty-four inches in length." Some of the dealers inform me that it has been scarcer of late years. Certain it is that, except in the autumn, it is of rare occurrence in our markets.

From *Microgadus californicus* this species may at once be recognized by the large size of the mouth and the union of the two posterior dorsals into one fin, each portion of which, as well as the first dorsal and the two portions of the anal, is highest near the center of its length.

Microgadus californicus, Gill; *Morrhua proxima*, Girard, Tomcod—This little fish is abundant throughout the year, and I am assured that when it is properly cooked no fish of the coast surpasses it in flavor. It may be at once known from every other fish by the three separate triangular dorsal fins, the first highest and all highest anteriorly, the small mouth, and the short barbel below the chin. In length it seldom exceeds eight or nine inches. It is common in the Bay of San Francisco.

SUBORDER HETEROSOMATA—FLAT-FISHES.

No tribe of fishes is probably so well known to that large class of naturalists whose love of nature takes a practical turn, who like best those creatures which taste best when boiled or fried, as the flounders, flat-fishes, or *Pleuronectidae*. Apart from their attractiveness to the sense of taste, they have one peculiarity which challenges the attention of the most uninterested observer of this world's living wonders—they have both their eyes placed on the same side of the head. If a little more attention be paid to this obvious feature, it will be found to be even a greater peculiarity than was at first supposed. The flounders are not the only fishes which have their eyes on the same side of the body; the skates, rays, torpedoes, and their relations are in this respect similar. Where then, lies the great difference between these two classes, for no one would confound the two, even at the first glance? Simply in this, that the skate and ray tribe are flattened downwards, the side which is uppermost is the proper upper side, and the eyes are placed in their usual position with regard to the other parts of the head; whereas, in the flat-fishes the body is flattened out sideways, the fish swims on one of its sides, instead of on the proper under-surface; and the eye which of right belongs to the side which is beneath, has twisted round out of its place, and is situated on the same side with the other, unsymmetrically with the other parts of the head. Of course this is not the only difference between the skates and the flounders. There are far more important anatomical differences, but it is one of the most obvious outward distinctions between two tribes which, though widely separated in other respects, resemble each other in having the eye so placed as to look upwards, in their thin flat bodies, colored upon the upper side only, or principally, and in their habit of residing at the bottom of the sea; their uncolored surface resting on the bottom. Again, the flat-fishes are not the only fishes which have a very wide body, flattened laterally; the sunfish is also very deep from dorsal to anal; and some of the mackerel tribe are even more excessively compressed; but these and all other laterally compressed fishes, except the flat-fishes, swim in the usual manner, dorsal fin uppermost, and the eyes are in the usual position—one on each side.

It will be readily understood that the two eyes cannot be brought round to one cheek without great distortion of the bones of the skull; many of the bones on the colored side are cramped in their development, squeezed into a narrow space, out of the way of the encroaching eye; while some of the bones of the blind side are correspondingly enlarged, filling up, by their lateral extension, the place where, so to speak, the eye ought to be. Now, a distortion of this importance, if it were not of universal occurrence in the whole tribe, would be considered a monstrosity; and it became an interesting question to ascertain at what point in the life history of these fishes the distortion commenced. Surely so very important and radical a modification of the skull and bones of the head must commence at the very first beginning of the formation of the fish, before it is hatched from the ovum. But it has lately been conclusively proved that this is not the case. Professor Alexander Agassiz has watched the development of young flounders, and has proved that when first hatched, they resemble other fishes in the position of the eyes and the symmetrical form of the head; and that the distortion is the result of habit, which habit again increases the distortion, precisely as claimed by the advocates of what is usually called "evolution." That is to say, the young fishes seek the bottom of the water, yet strive to use the lower eye. By the continued effort to use this, the soft structure of the head is affected, and an oblique upward view is gained. This renders the fish less fitted than before for locomotion in the usual manner, and more adapted for keeping at the bottom, which it accordingly does, with the result that the eye becomes more and more twisted till it at last has passed clear over the dorsal ridge of the animal, and makes its appearance on the same side with the other eye. This side is, in some species, the right, while in others it is the left side. All this takes place while the creature is young, before the bones are hardened. It would appear that in some cases, the eye literally passes through the head.

But it must be remembered that the bones of fishes are, as a whole, much softer than those of reptiles, birds, or mammals, and therefore much more capable of yielding to impressions from the outside without the destruction of the life of the organism.

Thirteen species of these fishes are now known to occur on this part of the coast, and all of them are brought to our markets more or less frequently. All these species belong to the family *Pleuronectidæ*, or flounders, from which the *Soleidæ*, or soles, are distinguished by the absence or rudimentary condition of the pectoral fins. Although no real sole occurs here, all the species except the two known as "halibut," that called "turbot," and another which the dealers know as "bastard turbot," are sold in the market under the name of "sole."

Hippoglossus vulgaris, Halibut—The rarest of these species is a true halibut, or *Hippoglossus*, which Professor Goode, the well known ichthyologist, believes to be identical with the Atlantic species *Hippoglossus vulgaris*. *Hippoglossus vulgaris*, an Arctic species, extends therefore along the coasts of Europe, eastern North America, and Northwest America, reaching on this coast the latitude of San Francisco, which is probably its most southern point. It is occasionally taken at the Farallone Islands, but as yet I have only seen a single specimen brought from thence. To the northward, about Vancouver Island, it becomes abundant, as it is also in Alaska. This fish is greatly

esteemed as an article of food, and, on account of its rarity, it has, until lately, commanded a high price. The individual above mentioned was retailed at fifty cents per pound.

A schooner has recently been fitted up expressly for the purpose of bringing fresh halibut, packed in ice, from Puget Sound, or its vicinity, to San Francisco. The trip down occupies about four days, and the fish, entire, with the exception of the viscera, arrive in perfectly good condition. Two trips have been taken this year, and halibut has been retailed at from ten to fifteen cents per pound. The three largest halibut taken weighed respectively 180, 190, and 220 pounds, and their weight with the viscera would probably be about one-fifth more. The individual weighing 190 pounds measured 7' 1" in total length, and had three or four rows of teeth in the front of each jaw.

Psettichthys melanostictus, Girard, Sole.—As most of the fishermen and fishmongers of San Francisco and its neighborhood are Europeans, principally Italians and other Mediterranean peoples, with a sprinkling of English and New Englanders, they have given to such fishes as they have thought worthy of a vernacular title names which properly belong to species found in the Mediterranean and Atlantic, and frequently, but distantly, related to their Pacific namesakes. In pursuance of this rule, the name of "sole" is applied to several species brought to the markets of San Francisco, and among these the most common is the one named above. It does not appear, so far as I have been able to ascertain, to be caught in any great quantity within the Bay of San Francisco, but is usually taken outside the heads and at the Farallone Islands. The greater portion of those sold in the markets are about ten inches in length, but some attain a length of eighteen inches or even more. This species may be readily distinguished from all the other flat-fishes of our coast by the form of the dorsal fin, the first rays of which, situated on the top of the head, are higher than those immediately succeeding them, and by the dark gray color, produced by black spots, just large enough to be recognized as such by the naked eye, upon a ground of a lighter tint. These black spots are not conspicuous in individuals just taken from the water, which are of a more uniform and far lighter color, but become so after a few hours exposure to the air. The interorbital space varies in width, apparently increasing with age, though not always in proportion to the size of the individual. The number of rays in the dorsal and anal fins is, as is not unusual among long-finned fishes, subject to considerable variation, the number of dorsal rays ranging from seventy-eight to eighty-eight and that of the anal rays from fifty-eight to sixty-two. The proportions of the body also vary considerably, some being much narrower than others, but the species is always more elongated than *Hippoglossides jordani*, with which it is often confounded. The scales are not smooth, as described by Girard, but ciliate upon their free margins; and there is also running along, close to and parallel with the dorsal outline of the anterior part of the body, a second or "accessory" lateral line, a feature which is repeated in several of the small-mouthed flounders. In the stomach of a specimen seven and a quarter inches long were the half-digested remains of two anchovies (*Engraulis ringens*).

Hippoglossoides jordani (nov. sp.), Sole—This species is tolerably common in the markets of San Francisco, but appears to have hith-

erto escaped description, probably on account of its considerable external resemblance to *Psettichthys melanostictus*, Girard, from which, however, it may be readily distinguished by the much larger eyes; the form of the dorsal fin, which increases toward the center instead of commencing with rays higher than those immediately succeeding them (as is the case in the latter species); by the narrower interorbital space; and, still more readily, by the color, which is more uniform and lighter, the black points upon the scales, which are conspicuous to the naked eye in *Psettichthys melanostictus*, not being evident unless viewed with a lens. In large specimens the head has a reddish tinge. The largest I have yet seen measured eighteen inches in length. In common with *Psettichthys melanostictus* this species bears in the markets the name of "sole," and many of the fishmongers, who readily distinguish from each other most of the species of flat-fishes, do not appear to discriminate between these. So far as I have been able to learn, it is taken outside the bay in the same localities with *Psettichthys melanostictus*. In form of body, size, structure of the mouth, scales, and lateral line, this species resembles the species previously mentioned; and the distinctions between them would, in fact, be considered only of specific value were it not for the presence in *Psettichthys melanostictus* of an accessory lateral line along the dorsal outline, a character which this species does not possess. A technical description of this fish has been published in the Proceedings United States National Museum, September, 1879, p. 73, and I have taken the liberty to name it after the distinguished ichthyologist, Professor D. S. Jordan, who has done more than any other American naturalist to increase our knowledge of the fresh water fishes of the United States, and who is at present engaged in preparing an Ichthyology of the United States, which will include the fishes of the Pacific Coast.

Those dealers who distinguish this fish from *Psettichthys melanostictus* do not appear to rate its value as an article of food equal to that of the latter; but the two kinds lie together on the stalls, and are sold for the same price. The scales are ciliate or rough upon their hinder margins, but less so than in the previous species.

Paralichthys maculosus, Girard, Monterey Halibut—This species attains a large size, larger than that of any other of our flat-fishes except the true halibut, *Hippoglossus*. Individuals of from 30 to 40 pounds weight are comparatively common. The two largest I have yet seen weighed respectively 43 and 58 pounds, and I am told that it reaches from 60 to 70 pounds. The example weighing 58 pounds measured nearly five feet in total length. Small individuals of this species, having the eyes and color on the right side, were described by Girard as *Paralichthys maculosus*. Subsequently Dr. Ayres described, under the name of *Hippoglossus californicus*, a form which proves to be really only the adult of Girard's species. As his examples were sinistral in their coloration, it was until very lately believed that these two names represented two distinct species, but it has now been proved that they are one species, which is sometimes dextral, sometimes sinistral. The row of bluish spots along the dorsal and abdominal outlines, which doubtless suggested the name *maculosus*, is present in the adult, but is less distinct; and the caudal fin, said to be convex in *maculosus*, and concave in *californicus*, proves to have a sinuous outline, the central and exterior rays produced beyond those

lying between them. The Monterey, or "bastard" halibut, as it is sometimes called, may be known from our other *Pleuronectidae* by its short head; elongate, regularly ovate form; small scales, with a row of long, narrow accessory scales along their free margin; and by the bold, abrupt arch made by the lateral line above the pectoral fins. In numbers it is not common compared with the two previously-mentioned species, but makes up in bulk during the months it is in season. Throughout the winter and early spring it is scarce, but large individuals become tolerably abundant in April, and throughout the summer the young are sometimes sold as "turbot." Those brought to market usually come from Monterey or its vicinity, but it also occurs northwards, at least as far as Tomales Bay, and southwards to San Diego, whence Girard's type was procured.

Citharichthys sordidus, Günther; *Psettichthys sordidus*, Girard, Left-handed Flounder—This species is brought in considerable numbers to the markets of San Francisco, and can be readily distinguished from every other kind occurring on this part of the coast by the combined characters of eyes and color on the left side, lateral line almost perfectly straight, bony, ridge-like interocular space, and insertion of the ventral fin of the colored side upon the ridge of the abdomen, instead of on the same level with that of the blind side. As is the case with many other species, the number of rays in the dorsal and anal fins is not constant. In color this fish is of a dirty yellow or yellowish-brown, with each scale margined with blackish and the fins speckled with the same. The scales are smooth and very flexible. As the dealers do not appear to have given it any title, I have here named it by its most obvious characteristic, namely, the presence of the eyes and color on the left side; not that it is the only species possessing this character, but because, so far as I have been able to observe, it is constant in possessing it, while the Monterey halibut and the species usually known here as the "flounder" (*Ptichthys stellatus*) are sometimes dextral, but in other cases sinistral. The left-handed flounder does not usually attain the dimensions of any of the previously described species, the usual length of those brought to market being only from ten to twelve inches. It is not taken within the Bay of San Francisco. How far its range extends either northward or southward I do not know, but in the latter direction it certainly reaches to San Diego, as a dried specimen, sent to the Smithsonian Institution by Dr. J. G. Cooper, furnished Professor Gill with the type of his new genus, *Metoponops*.

Glyptocephalus zachirus (Lockington, Proceedings United States National Museum, September, 1879, p. 83)—This hitherto unnoticed species of flounder owes its specific name to the great length of the pectoral fin of the right or colored side of the body. This fin is much longer than the head and about equal to one-fourth of the total length of the fish, but it can scarcely be of much value to locomotion, as only one or two rays are thus excessively lengthened, the others falling off rapidly on each side. This character alone is sufficient to distinguish it, not only from its nearest relation on this coast, *Glyptocephalus pacificus*, hereafter mentioned, but from every other species of flounder, and it is further characterized by the blunt, rounded form of the front part of the head, a character not shared to anything like an equal extent by any other of our flat-fishes. It also differs from its congener in the presence of a spine in front of the anal fin. The color, like that of many other of our fishes, is rather difficult to

describe. It is a more or less dark gray ash, formed by minute black points upon a lighter yet colored ground. On the blind side there are also numerous black points, but they beset a white ground, producing a light gray tint.

The two *Glyptocephali* of this coast may thus be distinguished from the other flounders by the coloration of their blind side, as well as by their exceedingly elongate form. As this fish has no name in our vernacular, it may be as well to call it the "long-finned flounder." The long-finned flounder is not taken in our bay, and I have not yet been able to ascertain the locality from which it is brought. I first noticed this species about March 21st, and from that date to July it has been almost regularly present, but always in small quantity. I have not observed it in August or September. The largest that I have yet seen measured $14\frac{5}{8}$ " in length and $4\frac{1}{4}$ " in depth, the length of the head being $2\frac{5}{8}$ " and that of the pectoral fin $3\frac{1}{16}$ ". The dorsal of this individual contained 98 rays and anal 81 rays; but some individuals have as many as 186 dorsal and 89 anal rays. I have experimented on the edibility of this fish, and pronounce it one of the best, if not the best, of our flat-fishes, an opinion in which I am borne out by others who have tried it.

Glyptocephalus pacificus, Lockington—On visiting the market, on the 13th of March, I found, among the small flat-fishes exposed for sale, two small specimens, which, from their excessively elongated form and the considerable thickness of the body, seemed new to me. These fishes were between eight and nine inches long, their width was but a little more than a fourth of their length (a most remarkable proportion for a flounder), and the short head was less than the greatest depth; the mouth was very small, the lateral line quite straight, the scales minute and quite smooth, and the color a dark, blackish gray, with the tips of the fins darker, approaching black. The dorsal fin, as might be expected from the proportions of the fish, was exceedingly elongated, and contained many more rays than that of any other of our flat-fishes, the two specimens having respectively 102 and 104 rays. The anal fin was correspondingly elongated, and contained 84 rays in one and 87 in the other. The teeth, twelve in number in the lower, and nine or ten in the upper jaw, were broad and flat, with a cutting edge, like the incisors of a mammal, and formed a close row along the jaws on the blind side and in front, while there were none upon the colored side. It agrees in the length of the dorsal, elongate body, smooth scales, and straight lateral line, with the genus *Glyptocephalus*, and has been described as *Glyptocephalus pacificus* in the Proceedings of the National Museum, September, 1879, p. 86.

This species cannot certainly be brought to market during the winter, as, though I was a regular visitor of the markets from September to March, I never met with it. From the date of its first occurrence until September this fish has usually been in the market, and during the summer has been comparatively abundant. The largest I have seen measured nearly twelve inches in length, and this is probably almost the limit of the growth of the species. In flavor it is excellent, but scarcely equal to its congener *Glyptocephalus zachirus*. This species and the preceding are taken in seines, in tolerably deep water, four or five miles from Point Reyes. The fishery is only two years old.

Platichthys stellatus, *Platichthys rugosus*, Girard—This species, com-

monly called flounder, is by far the most abundant of the kinds brought to our market, and attains a larger size than any other, except the bastard halibut (*Paralichthys maculosus*) and the *Hippoglossus*. The eyes and color are sometimes upon the left side, at others upon the right; a circumstance that has rather bothered naturalists, while it has served as a basis for fanciful theories among the fishermen. It may be readily distinguished by its short broad form, the width exceeding somewhat the half of the length (excluding the caudal fin); by the presence, instead of scales, of scattered, rough, stellated tubercles; and by the black bands upon dorsal, anal, and caudal fins, four upon the first, three upon the second, and three upon the last, all of them running in the direction of the rays. It is of wide distribution, occurring along the coast of Kamtschatka, and from thence extending by Behring's Straits, Alaska, and British Columbia southward to San Francisco. How far it may occur to the south of the latter point does not appear to be known with certainty, but as it is evidently a northern form, it is not unlikely that its southern limit will be found to be near Monterey, at which point there is a mingling of northern and southern forms, resulting in an extremely rich local marine fauna; rich not only in species of fishes, but in *mollusca*, *echinoderms*, and *coelenterates*. The flounder occurs within the Bay of San Francisco, and is brought to market not only from thence, but from various points outside of the heads; some are even sent from Humboldt Bay, but it is said that these are far coarser than those obtained elsewhere, with comparatively less meat, and fetch a much lower price in the market.

Those taken here attain a weight of eight, ten, or even twelve pounds, but those sent from Humboldt Bay are much heavier. In this species the number of the dorsal and anal fin rays does not appear to be subject to so much variation as in many other flat-fishes. Many of the fishermen believe that they know the reason why this fish is sometimes colored on the right, and sometimes on the left side. It is, they are confident, caused by the moon, and depends upon the side illumined by that orb at the time of fecundation. A far more intelligent theory, but one which yet lacks proof, is held by the fishermen and dealers, to the effect that those colored on the left side are females, while those colored upon the right side are males. The same theory is held in the case of the Monterey halibut. The old Russian naturalist, Pallas, first described this species, which was described by Girard in 1865. The identity of Girard's form with that of Pallas was noted by Gill (Proceedings of the Philadelphia Academy of Natural Science, 1862, p. 281), and by Günther (Catalogue of Fishes, British Museum, vol. IV, p. 443).

Pleuronichthys guttulatus, Girard, Turbot—This fish, the "turbot" of our markets, is one of the commonest of our flounders, but is usually of small size. Occasionally, however, individuals are taken weighing as much as five pounds, and measuring eighteen inches in length. The color alone is sufficient to distinguish it from all the other species. On the colored side it is, when quite fresh, of a dark olive green, sometimes blotched with irregular whitish spots. By exposure to the air the color deepens to nearly black. The underside is opaque white, like white lead, but along the margin of the head, from some distance above the eye, and continuing to the anus is a border of bright gamboge yellow, broadest and brightest upon the snout and lower jaw. Sometimes the whole of the under surface

is yellow. It is a very broad species, in this respect rivaling and even exceeding *Platichthys stellatus* (the "flounder"), the width being nearly or quite half of the breadth. Another characteristic may be found in the teeth, which, instead of being a single row, form several rows, a character shared only by one other of our flat-fishes, *Pleuronichthys canosus*, which differs widely in the color, as well as in having the dorsal fin continued downwards along the blind side of the head, and in the very much larger eyes. The number of rays in the dorsal varies from 66 to 72, and those in the anal from 47 to 54, a range which, had the two extremes fallen into the hands of two different naturalists, might well have led them to make two species. Nor has this fish, short as has been its literary history, escaped from a synonym. It was first described by Girard (Pacific Railroad Report, vol. 10, p. 152), who attributed to it 67 dorsal and 47 anal rays, and gave its color as "greyish, or lead, sprinkled all over with black dots and whitish spots." In 1862 Dr. A. Günther re-described it, under the name of *Parophrys ayresii* (Catalogue of Fishes, British Museum, vol. IV, p. 456), yet admitted *Pleuronectes guttulatus* as a species. The insufficient description of Girard was doubtless the cause of this error. Girard's specimen came from Tomales, and I am informed that it is in the neighborhood of Tomales Bay that most of the turbot brought to market are procured. This fish is much esteemed, and always commands a high price.

Pleuronichthys canosus, Girard—This is a rare species, and evidently inhabits deep water, since the eyes of those I have seen protrude from their sockets, through the sudden change from pressure at the depths where they reside to that of the surface. There are three characters about it which render it impossible to confound it with any other species: the very large eyes, which equal or exceed in diameter one-third of the length of the head, from the tip of the snout to that of the gill covers; the very short, snub snout, scarcely projecting beyond the protuding eye, and the singular course of the dorsal fin, the front part of which, instead of ending upon the dorsal ridge somewhere over the eyes, as in other species, curves over at that point to the blind side of the fish, and continues downwards along that side till it reaches a point level with, and not far from, the end of the maxillary or upper jaw. About eight rays are thus twisted over to the left side. The color also, a uniform warm reddish-brown, is very distinctive. The teeth, like those of the last species, (*Pleuronectes guttulatus*) are in several rows, and in the form of the body and fins the two kinds are also much alike.

Girard's original description was drawn from a single specimen, the only one he had seen. It is taken near the Farallones. The left or eyeless side is not always colorless, but has frequently several dark brown spots or blotches. The dorsal fin is occasionally carried further down on the blind side than is mentioned above, while in other cases only four rays are twisted over. During the winter this species did not occur in the market, but on the 26th of February one of the first of the season was brought to me, and since then it has gradually become more abundant until May, during which month it was as plentiful as *Lepidopsetta bilineata*, itself a rather rare species, also brought from the Farrallones.

Parophrys vetulus, Girard, Sole; Diamond Flounder—This is another of the common flat-fishes of our markets, and is grouped

with several others under the name of sole. It may be recognized by its elongate, narrow head, with the upper eye placed upon the dorsal ridge, so as to look dorsally as well as laterally, by its elongate, rhombic form, the outlines of the posterior portion of the body being nearly straight, and by the development of the teeth upon the blind side only, where they form a single row. In color it is usually of a uniform reddish ash, but some of the younger individuals are irregularly spotted with darker blotches. On the blind side it is creamy-white. The number of rays in the dorsal and anal fins varies from 74 to 86 and from about 54 to 68 respectively, a variation which has probably been the cause of the description of the nominal species, *digrammus* and *hubbardi*, by Günther and Gill. Those brought to market are from eight to fifteen inches long, and occasionally a little larger, but the species does not appear to attain the weight of *Psettichthys melanostictus* or *Hippoglossoides jordani*, as it is much more slender in form. It is usually taken outside the bay. As a food fish, according to my judgment, as well as that of those dealers who distinguish it, it is inferior to the two species just mentioned.

Lepidopsetta bilineata; *Platessa bilineata*, Ayres, Mottled Flounder—The first description of this fish will be found in the Proceedings of the California Academy of Sciences, vol. 1, p. —. It is one of the numerous forms described by Dr. Ayres, and has always been one of the rarest and least known of our fishes, very little having been added to our knowledge of it since Ayres wrote. It may be readily known from every other kind found here by the following characters: Many of the scales upon the body are ctenoid; that is, beset upon their hinder edges with spinules; those on the cheeks are tubercular or roughened with bluntish points upon a large part of their surface; the form is regularly oval, the width of the body almost equal to half of the total length, and the color a quite light yellow with irregular white spots.

As in so many other of the more nearly related flat-fishes, the teeth, which are in a single row, are not equally developed on the two sides of the jaws, but are principally upon the blind side. The eyes are large, forming $\frac{2}{3}$ of the length of the head. This species is only occasionally brought to the markets, where, with several species previously mentioned, it bears the name of "sole." Those brought are usually of tolerably large size, from fourteen to fifteen inches long, and are caught at or near the Farallone Islands, though probably not in such deep water as *Pleuronichthys cænosus*, since the eyes do not protrude, as is usually the case with the eyes of fishes suddenly brought up from deep water. On account of the spots upon its surface, I have given it the name of "mottled sole," or rather, mottled flounder. As a food fish it is excellent, yet is not considered equal to *Psettichthys melanostictus*. The lateral line, or row of pores which runs along the body from the head to the tip of the caudal fin, makes a bold, semi-circular arch over the pectoral fin; and there is, as in the three preceding species and the one following, an accessory line of pores running from some distance along the dorsal margin. This accessory lateral line is subject to curious modifications in its length and in the form of its anterior branches. The whitish blotches upon the colored side often form a series along the dorsal and abdominal margins.

Lepidopsetta umbrosa; *Platichthys umbrosus*, Girard—This species is most nearly related to the mottled sole from the Farrallone Islands

(*Lepidopsetta bilineata*), sharing with it the characters of rough scales and lateral line considerably arched above the pectoral fin. From that species it may be very readily distinguished by its color, which is of a dark uniform slaty brown, and from all other species by the combination of the two characters first mentioned, together with its regularly ovate form and small, quite laterally-placed eyes. It does not appear to be very common, as there are rarely above two or three specimens among a miscellaneous heap of flat-fishes, and the usual size does not exceed ten or eleven inches in length. From its small size and comparatively unfrequent occurrence it cannot be considered as of great value from an economic point of view. It is sold along with other species as "sole," and fetches the same price. The extent and boldness of the arch of the lateral line varies greatly.

SUBORDER ISOSPONDYLI.

This suborder is the *Physostomi* or *Malacopteri* of Cuvier and the older naturalists, minus the *Nematognathi* or *Silurians*; the *Haplomi* (pike-toothed minnows, etc.), and the *Eventognathi* or carp-like fishes. The fins are without spines (except one or two in dorsal or anal), the ventral has no spine, the scales are cycloid, the head is naked, and an adipose fin is present behind the true dorsal in some, while others have a serrated abdomen. The families, genera, and species included in this suborder are more numerous than those in any other, the *Acanthopteri* alone excepted, and among these families are two which, in their value to man, probably exceed any other, namely, the *Salmonidæ* and the *Clupeidæ*.

Of the remaining families one only, the *Synodontidæ*, sends a member to our markets in the person of *Synodon luciocephus*, Ayres, which is not improbably identical with *Sonodon* (Saurus) *fateus*, Linn, a species known to occur upon the Pacific coast of Panama. In September and October, 1878, numerous specimens of this species occurred in the market, most of them eight to ten inches in length, but one individual reached seventeen and three-fourths inches. It is occasionally taken in the bay.

SALMONIDÆ.

The *Salmonidæ* are by far the most important group of fishes on this coast. The species of greatest value belong to the genera *Oncorhynchus*, *Salar*, and *Salvelinus*. These will not be treated of here. The single species of *Coregonus* that is known to inhabit the fresh waters of the State is not brought to market, so the only salmonoids remaining for our notice are the small marine fishes forming the group of the *Microstomatidæ*. All the *Salmonidæ* have an adipose fin; the maxillaries enter into the formation of the lateral part of the upper jaw; the belly is rounded and without serratures, and the air bladder is large and simple.

Hypomesus olidus—This delicate fish is, at first glance, similar to the following species, but the mouth is very small, the end of the maxillary bone reaching only level with the front of the eye, while in *Osmerus thaleichthys* it reaches to the back of the orbit. The head also is somewhat smaller. But this fish, when fresh, can be most readily distinguished by the transparency of its flesh, which, of course disappears entirely in preserved specimens. The silvery band along the sides, which is found in all the four species, and is probably the cause of their being grouped together as smelts, is particularly bright in this fish. This species has been tolerably abundant in our markets from October to August. In size it is usually somewhat larger than *Osmerus elongatus* or *Osmerus thaleichthys*, attaining a length of about eight inches.

Osmerus thaleichthys is really the nearest representative of the smelt of Europe, having the peculiar, pleasant smell that suggests the name in that species, which is also a kind of *Osmerus*. It may readily be distinguished from the two species of *Atherinidæ*, *Chirostoma californiensis*, and *Atherinops affinis* by the want of spinous rays on the back, by the adipose fin, by the absence of the bright green tint, which is replaced on the back by a dull, greenish olive, on which a diamond

pattern is traced by rows of minute dark dots that fringe each scale, and by its smaller size. From *Hypomesus olidus* it may easily be known by the comparatively large size of the mouth and less transparent appearance. It is usually from five to five and a half inches in length. Its form is stouter than that of *Hypomesus olidus*, the flesh is soft in texture, and the pectoral fins reach very nearly to the origin of the ventrals. This form, like the last, has been present in the markets throughout the year in variable quantity.

Osmerus elongatus, Ayres—Among the fishes described in the early days of the California Academy of Sciences, by Dr. W. O. Ayres, was a species belonging to the smelt or *Osmeroid* group of the salmon family. A short description, unfortunately too short and incomplete for identification, was published in vol. 1, p. 17, of our Proceedings. Girard, in the Pacific Railroad Report, vol. 10, states his belief that Ayres' species is identical with the small-mouthed smelt of this coast. (*Argentina pretiosa*, Girard; *Hypomesus olidus*, Pallas, Gill). Examination of the small salmonoids brought to this market proves, however, that there are three species. One is Girard's small-mouthed species; another Ayres' *Osmerus thaleichthys*, described and figured in vol. 2, p. 62 of Proceedings of the Academy, while the third is almost certainly the *Osmerus elongatus* of the latter authority.

It is not easy for the unpracticed eye to tell these species apart, yet the differences are obvious when once recognized and are of a constant character. In this species the form of the body is more slender and elongated than in either of the other smelts, the dorsal fin is constantly farther back on the body, the lower jaw is long, resembling in this respect Ayres' other species, but differing from it in its straightness, that of *Osmerus thaleichthys* being curved upwards, and the profile of the top of the head differs from that of the last named form in the greater elongation and more pointed form of the snout. The dentition is strong, teeth being present on jaws, tongue, and palatines, the largest upon the front of the tongue. The dealers are able to distinguish the three species apart, trusting as much to the difference in the texture of the flesh, as evident to the touch, as to the variation in appearance. In alcoholic specimens this distinction is of course lost, and the species are harder to distinguish than when fresh. This may account for the union of two species under one name by Girard, though I believe it more probable that he never saw Ayres' species.

Among the heaps of small fishes sold for fry may usually be found all the three species of salmonoid smelts, the anchovy (*Engraulis ringens*), and small individuals of the smaller species of mullet-like smelt (*Atherinops affinis*).

CLUPEIDÆ.

This family as originally constituted comprised a large number of soft-finned fishes without an adipose dorsal, with the lateral margin of the upper jaw formed by the maxillaries, which are usually in three pieces, and with rather large scales. The sections of this large family have been lately raised to the rank of families, and are distinguished by very obvious features; thus the true *Clupeidæ* or herrings have the abdomen compressed to a sharp edge, which is set with a row of plates forming serrations; the lateral line is absent, and the teeth either very small or altogether wanting; the *Engraulidæ* or anchovies have the abdomen rounded, the upper jaw much longer than the lower, which is toothless, the mouth large, and the sides with a bright silvery band; while the *Albulidæ* or lady-fishes have a rounded abdomen, the upper jaw rather the longer, both jaws set with bands of villiform (velvet-like) teeth, and the roof and floor of the mouth covered with pavement-like patches of coarse granular teeth. These *Clupeidæ* are represented upon our coast by at least four species, three of which are of sufficient importance to rank as food fishes.

Albulavulpes, the sole member of the *Albulidæ*, and in many respects a very singular species,

is a widely distributed fish, occurring in both the great oceans. Single individuals occasionally find their way to this market, probably from Monterey Bay.

Clupea mirabilis, Girard, Herring—This species may be known from the succeeding one by the projecting lower jaw, deeper and thinner body, and by the absence of conspicuous striations upon the gill-covers. It comes into the market in September and continues in season until late in the spring. North of Puget Sound it is said to occur throughout the year, and shoals visit various points upon the coast of California during the rainy season. The business of curing the fish is not extensive, and the dried fish is said to be inferior to that of the Atlantic herring, though it is probable that the inferiority is mainly in the method of preparation.

Clupea sagax, Jenyns, Sardine—This is a thicker, less deep, and somewhat longer fish than the last, the jaws are equal in length or nearly so, and present no trace of teeth, and the operculum has conspicuous radiating striæ, descending towards the sub-operculum. The form of the ridges on the upper surface of the head is also very different. The colors are exceedingly intense in the fresh fish, bluish-purple predominating, and there is a row of dark spots along each side. It is in season during the summer and winter, and is taken in the Bay of San Francisco.

Engraulis ringens, Jenyns, Anchovy—A species exceedingly common in the bay, and extending along a great part of the Pacific Coast of America. By the large mouth, with the upper jaw projecting beyond the lower, the present genus may be at once known from *Clupea*, and the present species is the only one of the genus which I have yet recognized in our markets. Although so near to the highly esteemed anchovy of Europe this fish does not appear to be in great favor, judging from the large number which are wasted by the fishermen, but it is at least useful as forming a large proportion of the food of the flat-fishes; if I may judge from the fact that I have found it in the stomachs of three species of that tribe. As the *Pleuronectidæ* live on the bottom, I presume that the anchovy is also an inhabitant of the lower strata of the water. Abundant though this species is, it is not cured or preserved in any way, but I am told that an abortive effort in this direction was once made.

SUBORDER EVENTOGNATHI.

The *Eventognathi* of Professor Gill, or *Cyprinidæ* of the older authors, are chiefly distinguished by the total absence of teeth upon jaw, vomer, or palatines, the only teeth they possess being those upon the pharyngeal bones at the entrance of the œsophagus. They are without a spinous dorsal or anal spine. The scales are cycloid, and in many cases of large size; there is no adipose dorsal fin, and the surface of the head is without scales. They are inhabitants of fresh water, and occur in both the eastern and western hemispheres. The family *Catostomidæ*, or suckers, is almost peculiar to America, and several of its species occur in California, although but one is brought in sufficient quantity to the markets of this city to be worthy of mention as a food fish.

Species of the true *Cyprinidæ* abound in the waters of this State, and several are brought to market with tolerable frequency; others more rarely. None of them, however, are very highly prized for food.

The *Catostomidæ* are distinguished by a mouth opening more or less downwards and furnished with conspicuous fleshy lips, the intermaxillaries, and by lower pharyngeal teeth in a single series—numerous, closely-set, comb-like, across the bone. There are no barbels, and the air bladder is large, divided into two or three portions by transverse constrictions.

The *Cyprinidæ* are without the thick, fleshy lips which characterize the last family; the pharyngeal teeth are few in number, rarely more than seven on each side, but often in two or three series. Barbels are often developed upon the lower jaw, and the air bladder is usually divided into an anterior and a posterior lobe.

Gila grandis, Ayres, Girard, Pike—This, as Ayres enthusiastically remarks, "is by far the finest fish of its family known to inhabit the waters of this continent."

It did not occur in the markets of this city in October, November, or December; but from January 6th, when I first observed an individual 2' 9½" long, until the end of May, has been tolerably abundant. The largest measured by Ayres was three feet long, but he reports examples weighing thirty pounds, and I have been told that it sometimes approaches four feet in length.

The name "pike," under which it is now generally sold, is as great a misnomer as that of "salmon trout," which Ayres gives as a dealer's name. The absurdity of both names will be evident to any one who remembers that both pike and salmon have a mouth liberally supplied with teeth, while the *Cyprinidae* are all literally toothless as regards the mouth, their only teeth being on the pharyngeal bones in the throat. But the shape of the head, depressed in front, recalls that of the pike. It is a handsome fish, dark greenish gold on the top of the head, and the same, but lighter, on the back, and still lighter behind the dorsal fin, the color fading on the sides to silvery with golden reflections, and on the abdomen to plain silvery.

As the largest species found east of the Mississippi, *Semotilus bullaris*, rarely attains, according to Professor Jordan, "a weight of three or four pounds, and a length of nearly eighteen inches," it is evident that the present species is a giant among the minnows.

Pogonichthys maculobus, Girard, Split-tail—This species has been brought to market in tolerable abundance during the spring in company with *Catostomus occidentalis*, *Orthodon microlepidotus*, and *Gila grandis*. It may at once be known by the great length of the upper lobe of the tail fin, which projects considerably beyond the lower and has suggested the name of "split-tail," by which it is known in the markets.

Orthodon microlepidotus, Girard, Fan-tail—This is another of the more abundant *Cyprinoids* of our markets, brought in company with the three previously mentioned species. It attains a length of thirteen or fourteen inches. In color it is metallic greenish gold above, the top of the head dark olive green, with iridescent suborbitals, sides bright metallic silvery, lower surface silvery white. The surface of the head is crossed by a complex system of rows of pores, the caudal fin is large and fan-shaped, and the scales are remarkable from their small size.

Siboma crassicauda, Girard, which may fitly be named the thick-tail, is of occasional occurrence, as is also *Lavinia exilicauda*.

Catostomus occidentalis, Ayres, Western Sucker—This species is tolerably abundant in our markets at certain seasons, the supply being obtained from the Sacramento or its tributaries. Jordan (Bulletin United States Natural Museum, vol. 12, p. 172) mentions its occurrence in Green River, Wyoming, and says of its habitat "streams west of the Rocky Mountains, probably generally distributed." It is the only *Catostomoid* I have yet seen in the markets, and I did not observe its occurrence there until February, since which time the supply has been tolerably regular. The usual size of those brought here is from twelve to sixteen inches long. The scales are of variable size, increasing in size from the head backwards, so that the largest are upon the caudal peduncle and the smallest on the back, just behind the head. The scaleless head has a well-

developed system of pores. In color it is not a very dark olivaceous above, with bluish silvery reflections, becoming lighter posteriorly. Each scale of the dark colored portion is darkest around its edges, rendering the pattern of the scales very distinct. The color fades into silvery on the sides, and silvery white below, with metallic reflections, most evident on the base of the caudal.

SUBCLASS GANOIDEI.

The fishes constituting this subclass vary immensely in structure, so much so that almost every genus constitutes a family, and every family is equivalent to an order; so much so that our leading systematists are divided in their opinions as to the limits of the subclass, and have weighted the world with arguments to prove that the curious mud-fishes (*Leptodosticus* and *Protopterus*) of South America and of the Gambia belong to it, and vice versa; and so much so that some have even suggested the dismembering of the subclass, considering the differences in structure among its members to outweigh the resemblances. All agree, however, in the importance and great extent of the structural peculiarities of each group; although the characters they possess in common are two only, the arterial bulb (of the heart) with several rows of valves, and optic nerves which do not simply cross, but form a chiasma. In common with the sharks and rays, they have heterocercal tail, that is a tail with the upper lobe, containing a prolongation of the vertebral column, longer than the lower, which is developed below it like a second anal fin; the air bladder differs in structure in the various groups, and the bony or ganoid enamelled plates which characterize some of the more typical form are wanting in others.

The only ganoid fishes found on this coast belong to the *chondrostei* or cartilaginous ganoids, or, which is the same thing, to the family *Acipenseridae* or sturgeons. The skeleton is cartilaginous, five longitudinal rows of bony shields run along the elongate, subcylindrical body; the toothless mouth is a transverse slit on the under side of the head, in the same position as that of the shark; in front of the mouth are four barbels; and the dorsal and anal fins are set far back. There are no gill rays or branchiostegals; a large air-bladder, and the intestine has a spiral valve. The species are numerous; three or four occur on this coast, but only one is brought to our markets in quantity.

Acipenser brachyrhynchus, Ayres, Sturgeon—This is the only species of sturgeon which is brought to market in abundance, as the fishermen have a prejudice against the long-nosed or green sturgeon, *Acipenser acutirostris*, Ayres, which is abundant in the bay and the rivers and creeks flowing into it, asserting that it is poisonous. *Acipenser brachyrhynchus* is always in season, and always abundant, the weight of its flesh sold in the markets probably exceeding that of any other single species, excepting, perhaps, *Oncorhynchus quinnat*. It attains a very large size. On February 25th of this year I measured an individual 9' 9" long, the weight of which was 427 pounds. But even this was exceeded by a specimen brought to the California Market Christmas, 1878, measuring nearly twelve feet in length and weighing about 600 pounds. Examples of this size are of course rare. Caviare is manufactured in considerable quantities from the roe. Dr. Ayres describes a third species, *Acipenser medirostris*, but I have not yet recognized it.

SUBCLASS ELASMOBRANCHII.

The animals belonging to this class are commonly called fishes, but are distinguished by so many peculiarities of structure that they may be regarded as a subclass. This subclass contains the sharks, the rays, and the *Chimæroids*, examples of each of which groups may be found upon our coast.

In these fishes the skull is formed of cartilage alone, and no membrane bones (such as the parietal, frontal, etc.) are developed in relation to it; the gills are not free; the branchial openings are slit-like, and, (except in the *Holocephali*, or *Chimæroids*), several in number, there are no scales, but the external hard parts are what is known as placoid, composed of calcified papilla; and the eggs are few and large; some are ovo-viviparous. The minute structure of these placoid points or scales is precisely the same as that of teeth, which are also dermal in their origin. In the *Holocephali* the upper jaw and its suspensorial cartilages are wanting in a separate condition, as the parts representing them are united into a continuous cartilaginous plate, which is

continuous also with the skull itself; and the branchial clefts are covered by an opercular membrane, so that the opening is single; but in the sharks and rays, which form by far the largest order, the upper jaw and the suspensorial cartilage are distinct from each other, and are moveable upon the skull, and there are several gill openings. The teeth are usually numerous, whereas in the *Chimæras* they are not more than six in number.

There is no doubt that the sharks and rays are good for food; they may not be so delicate as a flat-fish or a salmon, but they would furnish an acceptable and wholesome addition to our food stock. One species, *Raia binoculata*, the common skate of our coast, is habitually eaten; the Chinese eat other species; the poor people along the sea-coast of England eat dog-fishes; shark's fins are a delicacy in China. If the prejudice against them could be removed, the consumption of these destructive fishes would aid greatly in reëstablishing the balance of life in the waters. What chance have our more prized fishes to perpetuate their race, when, in addition to the numerous enemies they previously had to contend with, man comes with his small-meshed nets, kills twenty young for every adult he needs for food; and in addition to this, artificially keeps up a colony of sea-lions at the entrance of the bay, while he neglects to take or kill the destructive sharks and rays, or to thin the schools of porpoises that revel in fish slaughter. Not that it would be advisable to destroy the colony of sea-lions which form one of San Francisco's greatest attractions, but it needs judicious thinning.

The commonest species of sharks found in the bay and its neighborhood are *Triakis semifasciatus*, the striped or tiger shark, which may readily be known by the dark stripes that descend from the back towards the belly, and which attain a length of more than five feet. *Mustelus*, Gill, a smaller species of uniform color; *Hexancus indicus*(=*Notorhynchus maculatus*, Ayres,) with seven gill openings instead of the usual five, and very peculiar many-cusped teeth; and *Rhinobatus productus*, Ayres, with very large pectorals, approaching the skates in form, but with the hinder part of the body shark-like. *Squatina angelus*, the angel-fish or monk-fish, of singular form and forbidding aspect, with a mouth that is terminal instead of underneath the head, and large pectorals, is occasionally taken.

Of rays, besides the common skate, we have *Rhinoptera vespertilio*, Ayres, a species with a thick head and an array of flat six-sided teeth, fitted together with all the regularity and closeness of a tessellated pavement. As this form has a wicked-looking serrated spine on its long tail, it is commonly called the sting-ray or stingaree. This is the species which, more than any other of its class, commits depredations on the oyster beds so industriously planted along the shores of our bay. A species of torpedo is sometimes met with, but is rare. Of the curious *Holocephali*, so called because the cartilage of the head is all in one piece, we have *Chimæra colliciei*, Bennett, *Hydrolagus colliciei*, Gill, a species which is distributed widely along the Pacific coast, and has occasionally been taken near San Francisco.

Raia binoculata, Girard, Skate—This alone, among the numerous rays and sharks which inhabit the bay, is brought to market regularly as an article of food. It is a very near relation of *Raia batis*, but the spines upon the head differ from those of that species. Many specimens have on each pectoral fin a large sub-circular black ring enclosing a black spot of similar form, but this is by no means constant, since though present in some examples eighteen inches or more across the fins, it is often wanting in much smaller specimens. A

parasitic *Lernean* is sometimes attached to the ventrals. The skate is abundant in the bay, and is also taken at various points along the coast.

CLASS MARSIPOBRANCHII.

Under this name are included the lampreys or lamprey eels, and the myxines or hags, two tribes which differ from other fishes so widely that naturalists consider them a separate class. The body is long and worm-like, without a trace of the paired fins, pectorals and ventrals, which are the homologues, be it remembered, of our own limbs; but with the vertical fins, dorsal, anal, and caudal, more or less developed. But the greatest structural differences lie deeper. The whole class has an incompletely developed skull, without a trace of a lower jaw; the mouth is a round opening formed for suction, and the gills are purse-shaped, usually seven on each side. There is only a single nasal opening, which is central. In the *Petromyzontide* or lampreys the branchial sacs and openings are seven on each side, the intestine has a spiral valve, and the nasal duct is a blind sac, not penetrating the palate; the mouth is armed with horny teeth, which rest on papillae. The young of these fishes differ considerably from the adults, and were formerly described as distinct genera. In the myxines the mouth is surrounded by barbels, the intestine is without a spiral valve, and the nasal duct penetrates the palate.

None of this group are usually brought to the markets of this city, but as the rivers of California contain several species which are known as "eels," and largely eaten in some localities, they need mention among our food fishes. Eel River, in Humboldt County, is named from the abundance of these lampreys, which are highly esteemed. The species known are *Lampetra plumbea*, Gill = *Petromyzon plumbeus*, Ayres; and *Entosphenus tridentatus*, *epihexodon*, and *astori*. A Myxinoid, *Bdellostoma stoutii*, Lockington, with ten teeth in the first, and nine in the second row, occurs also in Eel River, and a small example, presumably of the same species, was caught in the Bay of San Francisco.

LIST OF THE PRINCIPAL FISHES FOUND IN THE MARKETS OF SAN FRANCISCO BETWEEN OCTOBER FIRST, EIGHTEEN HUNDRED AND SEVENTY-EIGHT, AND SEPTEMBER THIRTIETH, EIGHTEEN HUNDRED AND SEVENTY-NINE.

The succeeding list is necessarily very incomplete, and is offered with apologies, as a commencement only, and a prelude to a more thorough catalogue. The reasons for its incompleteness are:

First—The fact that the writer had not, when the list was commenced, identified some of the known species, or detected the presence of species he has since described.

Second—The inability of the writer to be in the markets every morning early. The fish from Tomales, and places near the bay, arrive about 12:30 P. M., those from Monterey and more distant parts, about 4:30 P. M. The writer has visited the markets twice or thrice a week on the average, usually about 12:30 P. M. At that hour the mackerels and other fish from the south are usually all sold off, and it is probable that several of the rarer fishes occurred more frequently than he is aware of.

It must be remembered that the list refers only to the comparative abundance or scarcity of the various species in the markets, and, therefore, at least in the case of such fishes as the *Blennioids*, *Cottoids*, etc., not in great repute as food fishes, furnishes no index for their abundance in the waters. Several kinds which occurred on one or two occasions only, and were then only present by accident among other fishes, are omitted from the list.

Reference: , a—tolerably abundant; b—scarce, never many on the same day; ab—occurring seldom, but abundant when present.

The letter *a* does not necessarily indicate that the species is abundant, but simply that several specimens were seen on several occasions during the month.

As it was not until the latter part of the year covered by this list that I examined the two species of herring (*Clupea*) sufficiently to distinguish them at sight, I have marked with an ? those months in which I think it likely that they occurred.

The English names given are, when printed in ordinary type, those by which the species is known among the dealers; when printed in *italics* they are proposed by the writer.

FISHES IN SAN FRANCISCO MARKET.

SCIENTIFIC NAME.	ENGLISH NAME.	1878.			1879.											
		October	November	December	January	February	March	April	May	June	July	August	September			
PERCID.E.																
<i>Archoplites interruptus</i>	Sacramento River Perch					a	a	a	a	a	a	a	a			
<i>Stereolepis gigas</i>	Jew-fish									b	b		b			
CHIRID.E.																
<i>Chirus guttatus</i>	Spotted <i>Chirus</i>	a	a	a	a	a	a	a	a	a	a	a	a			
<i>Chirus constellatus</i>	Ringed <i>Chirus</i>	a	a	a	a	a	a	a	a	a	a	a	a			
<i>Anoplopoma fimbria</i>	Candle-fish	b						b	b	b	b	b	a			
<i>Ophiodon elongatus</i>	Green Rock-fish	a	a	a	a	a	a	a	a	a	a	a	a			
SCORPENID.E.																
<i>Sebastes paucispinis</i>	Small-scaled Rock-fish		b	b	b	b	b	b	b			b	b			
<i>Sebastes nigroocinctus</i>	Black-banded Rock-fish		a	a	a	a	a	a	a	a	a	a	a			
<i>Sebastes ruber</i>	Rough Red Rock-fish	a	a	a	a	a	a	a	a	a	a	a	a			
<i>Sebastes nebulosus</i> = <i>fasciatus</i>	Clouded Rock-fish	a	a	a	a	a	a	a	a	a	a	a	a			
<i>Sebastes rosenus</i> = <i>oculatus</i>	Pink-spotted Rock-fish		a	a	a	a	a	a	a	a	a	a	a			
<i>Sebastes melanops</i>	Black Rock-fish	a	a	a	a	a	a	a	a	a	a	a	a			
<i>Sebastes flavus</i>	Yellow Rock-fish	a	a	a	a	a	a	a	a	a	a	a	a			
<i>Sebastes auriculatus</i>	Black-eared Rock-fish	a	a	a	a	a	a	a	a	a	a	a	a			
<i>Sebastes pinniger</i>	Smooth Red Rock-fish	a	a	a	a	a	a	a	a	a	a	a	a			
COTTID.E.																
<i>Scorpenichthys marmoratus</i>	Bull-head, Marble Sculpin			b	b	b	b	b		b		b	b			
<i>Utemilepidotus spinosus</i>	Rough-backed Sculpin				b						b					
<i>Leptocottus armatus</i>	Yellow Sculpin					b		b								
<i>Artedius pugettensis</i>	Big-headed Sculpin					b				b						
SCIIDID.E.																
<i>Atractoscion nobilis</i>	Sea Basse	a				a	a	a	a	a	a	a	a			
<i>Genyanemus lineatus</i>	King-fish Little Basse	a	a	a	a	a	a	a	a	a	a	a	a			

FISHES—Continued.

SCIENTIFIC NAME.	ENGLISH NAME.	1879.											
		1878.											
		October	November	December	January	February	March	April	May	June	July	August	September
<i>Osmerus thaleichthys</i>	<i>Curve-mouthed Silver Smelt</i>	a	a	---	a	a	a	a	a	a	a	a	a
<i>Osmerus elongatus</i>	<i>Elongate Silver Smelt</i>	a	a	---	a	a	a	a	a	a	a	a	a
<i>Hypomesus olidus</i>	<i>Small-mouthed Silver Smelt</i>	a	a	a	a	a	a	a	a	a	a	a	---
CLUPEIDÆ.													
<i>Clupea sagax</i>	Sardine	?	?	?	?	?	b	b	a	a	a	a	a
<i>Clupea mirabilis</i>	Herring	?	?	?	?	?	?	?	?	?	?	?	?
<i>Engraulis ringens</i>	Anchovy	?	a	a	a	a	a	a	a	a	a	a	a
<i>Alosa sapidissima</i>	Shad	b	---	---	---	---	---	b	b	b	b	b	---
CYPRINIDÆ.													
<i>Catostomus occidentalis</i>	Western Sucker	---	---	---	a	a	a	a	a	---	---	---	b
<i>Carassius vulgaris</i>	German Carp	---	---	ab	ab	ab	---	---	---	ab	---	---	---
<i>Gila grandis</i>	Pike, <i>Pike-headed Gila</i>	---	b	---	b	a	a	a	a	a	a	---	---
<i>Pogonichthys inaequilobus</i>	Split-tail	---	---	---	---	---	ab	ab	ab	ab	---	---	ab
<i>Orthodon microlepidotus</i>	<i>Small-scated Orthodon</i>	---	---	---	---	ab	ab	ab	---	a	---	b	---
<i>Lavinia crassicauda</i>	Thick-tail	---	---	---	---	b	b	---	---	---	---	---	b
SILURIDÆ.													
<i>Amiurus albidus</i>	Cat-fish	---	---	---	ab	ab	ab	ab	ab	ab	---	b	a
ACIPENSERIDÆ.													
<i>Acipenser brachyrhynchus</i>	Sturgeon, <i>Short-nosed Sturgeon</i>	a	a	a	a	a	a	a	a	a	a	a	a
ELASMOBRANCHII.													
<i>Tricis semifasciatus</i>	Tiger Shark	---	---	---	---	---	b	---	---	---	---	---	---
<i>Musculus limulus=californicus</i>	Dog-fish	---	---	---	---	---	---	---	---	---	b	---	---
<i>Rhinobatus productus</i>	<i>Skate-shark</i>	---	---	b	---	---	---	---	---	---	---	---	---
<i>Squatina angelus</i>	Monk-fish, Angel-fish	---	---	---	b	---	---	---	---	---	---	---	---
<i>Raja binoculata</i>	Skate	a	a	a	a	a	a	a	a	a	a	a	a

NOTE.—*Clupea mirabilis*. The Herring season is at its light in November.

RECEIPTS AND EXPENDITURES.

The following is an account of receipts and expenditures since our last report:

Receipts.

November 16, 1877—By cash on hand, last report.....	\$3,563 13
February 19, 1878—By cash returned from Livingston Stone.....	30 61
November 29, 1878—By cash, warrant one-half of appropriation.....	2,500 00
February 25, 1879—By cash, warrant one-half of appropriation.....	2,500 00
August 16, 1879—By cash, warrant appropriation for this year.....	5,000 00
	\$13,593 74

Expenditures.

November 26, 1877—To paid Wells, Fargo & Company, expressage on report.....	\$0 50
November 30, 1877—To paid McKenna, expenses in making arrests.....	100 00
December 7, 1877—To paid telegrams to Sacramento.....	1 30
December 20, 1877—To paid postage and telegram.....	1 25
December 28, 1877—To paid Wells, Fargo & Company, expressage on trout, eggs, and telegram.....	51 10
December 31, 1877—To paid Woodbury, foreman at hatching-house, one month's salary.....	150 00
January 3, 1878—To paid purchase of spawning fish.....	2 30
January 8, 1878—To paid R. M. Davis, expenses in four arrests and convictions.....	200 00
January 10, 1878—To paid Jacob Underhill, hardware for hatching-house, and telegram.....	53 52
January 17, 1878—To paid Whitby, carpenter, expressage on L. L. salmon and white-fish eggs, etc.....	156 95
January 21, 1878—To paid lumber for hatching-house, and Wells, Fargo & Co. on land-locked salmon eggs.....	179 50
January 28, 1878—To paid nails, paint, etc., and expressage on fish eggs.....	63 35
January 29, 1878—To paid Palmer & Son, 25,000 trout eggs; Stone & Hooper, 45,000 trout eggs.....	251 75
February 2, 1878—To paid Whitby, carpenter, on labor, hatching-house.....	100 00
February 4, 1878—To paid Fitzpatrick, labor, one month, to 1st.....	40 00
February 5, 1878—To paid Whitby, carpenter, balance.....	92 50
February 19, 1878—To paid L. Stone, balance hatching 2,200,000 salmon.....	500 00
February 19, 1878—To paid Woodbury, one month's salary.....	150 00
February 19, 1878—To paid wire cloth, flannel, and expressage.....	58 15
March 8, 1878—To paid expressage on trout to Santa Barbara, L. L. salmon, to Summit, etc.....	22 50
March 8, 1878—To paid Underhill, hardware and furnishing hatching-house.....	160 07
March 18, 1878—To paid Wells, Fargo & Company, expressage on fish to sundry points, drayage of cans, etc.....	43 10
March 18, 1878—To paid Woodbury, salary, one month.....	150 00
March 18, 1878—To paid Fitzpatrick, salary, one month.....	60 00
March 21, 1878—To paid Clark, work on hatching-house and expressage.....	41 10
March 21, 1878—To paid land-locked salmon to Donner Lake.....	12 50
March 26, 1878—To paid Whittier & Fuller, asphaltum and drayage of cans.....	5 80
April 3, 1878—To paid Woodbury, on account, \$20; ice, \$6 50.....	26 50
April 6, 1878—To paid expressage on land-locked salmon to Tulare Lake.....	20 00
April 6, 1878—To paid labor and expenses in distributing cat-fish.....	50 00
April 15, 1878—To paid Woodbury, salary.....	145 50
April 15, 1878—To paid Fitzpatrick, labor.....	60 00
April 15, 1878—To paid Stratton, Kirkham, and Wells, Fargo & Company, for transporting cans and fish.....	24 10
April 16, 1878—To paid telegrams and drayage.....	1 50
April 17, 1878—To paid expenses in transporting trout to Alder, Nevada, and Russian River.....	36 19
April 17, 1878—To paid Myron Green for 32,000 McCloud trout eggs.....	128 00
April 27, 1878—To paid bill of Taylor & Company, for lumber for hatching-house, troughs, etc.....	76 39
May 6, 1878—To paid Fitzpatrick, in full, for labor to May 1st.....	30 00
May 6, 1878—To paid Woodbury, on account.....	20 00

May 11, 1878—To paid expressage on fish and cans, etc.....	11 92
May 11, 1878—To paid Woodbury, services and sundry expenses in full	135 40
May 19, 1878—To paid Woodbury, expenses to Pit River and return	125 00
June 7, 1878—To paid Woodbury, balance expenses and telegram	11 00
June 18, 1878—To paid ice for shad, freight, and expressage, etc	8 40
August 13, 1878—To paid purchase and distribution 12,700 cat-fish in seven counties..	129 75
August 14, 1878—To paid ice and expressage of fish	16 20
August 19, 1878—To paid Mr. Glashan, expenses Truckee and Tahoe	46 85
September 18, 1878—To paid Pither, procuring and distribution 5,200 cat-fish in five counties	104 00
October 1, 1878—To paid telegrams and cat-fish for San Joaquin	15 40
October 26, 1878—To paid Pither, catfish for exchange to Honolulu	13 75
November 4, 1878—To paid Woodbury, on account \$50 copying notices, telegrams, etc..	66 25
December 6, 1878—To paid Stone, hatching 500,000 salmon, telegrams, etc.....	262 00
December 11, 1878—To paid Cowdery & Preston, case of Ashton vs. McLean	20 00
December 27, 1878—To paid freight and express, white-fish eggs from Michigan	24 15
January 3, 1879—To paid freight and express, white-fish eggs from Michigan	112 40
January 3, 1879 To paid Stone & Hooper, and Myron Green, trout eggs	167 20
January 3, 1879—To paid Woodbury, balance salary, flannel, and stationery	120 00
January 6, 1879—To paid wire cloth, and transporting white-fish to Tahoe	31 15
January 15, 1879—To paid L. Stone, on account purchase 2,500,000 salmon eggs	500 00
January 18, 1879—To paid expense white-fish to Reno and Tahoe	20 00
February 3, 1879—To paid Woodbury, salary for January, \$150, express, \$16 50	166 50
February 5, 1879—To paid Richardson, one month's labor, \$100: expenses on white-fish to Tulare, \$35 30	135 30
February 10, 1879—To paid Palmer & Sons, 25,000 trout eggs	63 00
February 27, 1879—To paid expenses distributing trout	30 25
March 2, 1879—To paid Richardson, one month's labor	100 00
March 6, 1879—To paid Woodbury, one month's salary, \$150 00, expenses, etc.....	165 75
March 6, 1879—To paid L. Stone, balance due for 2,500,000 salmon	600 00
March 20, 1879—To paid Pither, 2,000 cat-fish, Yolo, \$42 50; Sheriff's fees, Sonoma, \$6 70	49 20
March 20, 1879—To paid expenses examining dams on Tuolumne, wire-cloth, and telegrams	13 25
March 29, 1879—To paid Woodbury, salary one month, \$150 00; distributing trout, expenses, etc.....	173 50
April 8, 1879—To paid distributing trout in San Mateo and Santa Cruz, etc.....	34 85
April 14, 1879—To paid Richardson, one and one-half month's labor, \$150 00; Woodbury, one-half month, \$75 00	225 00
April 14, 1879—To paid express on fish and cans	15 95
April 14, 1879—To paid Myron Green for 50,000 trout eggs	200 00
April 19, 1879—To paid Jones, transporting trout, American River	10 00
April 23, 1879—To paid for ice in transporting fish, \$21 50; tin strainer, \$3 00	24 50
May 8, 1879—To paid Stone, on account for transporting lobsters, etc., \$500 00; exchange, \$1 50	501 50
May 22, 1879—To paid telegram, \$2 00; draft of L. Stone, account for transporting lobsters, eels, etc.	805 10
June 2, 1879—To paid Pither for distributing 3,500 cat-fish in five counties	88 75
June 13, 1879—To paid cash for salt-water, telegram, and transporting fish to Lake County	18 00
June 19, 1879—To paid for transporting black bass to Crystal Springs Lake, \$1 50; L. Stone, balance, \$200 00	201 50
June 24, 1879—To paid W. N. Lockington, for services and report on marine fishes..	100 00
June 27, 1879—To paid for repair of wagon broken in transporting fish	7 50
August 14, 1879—To paid Pither, for distributing 2,500 cat-fish in three counties, barrels, etc.	65 10
August 18, 1879—To paid steamer Neptune for transporting lobsters	100 00
August 26, 1879—To paid H. D. Dunn for four days' services at Collinsville	28 25
September 1, 1879—To paid for distributing 3,700 cat-fish to Pit River, Truckee, Los Angeles, and Lassen Counties	113 95
September 8, 1879—To paid Lansing, for gathering statistics, \$50 00; express, \$10 40; ice, \$10 00	70 40
September 16, 1879—To paid J. C. Frazer, 50,000 trout for Truckee, South Yuba, and American Rivers	254 30
September 23, 1879—To paid H. C. Marks on account copying report	40 00
September 28, 1879—To paid distributing 3,500 catfish, Mendocino, Solano, Nevada, Lassen, and Mono Counties	112 40
November 1, 1879—To amount on hand to balance	3,873 70
Total	\$13,593 74

This balance of \$3,873 70 remaining on hand will be expended in payment for the 2,500,000 salmon eggs now hatching on McCloud River, and in the distribution of the young fish in that stream, the Pit, and Sacramento, as well as in the necessary expenses to be incurred in hatching white-fish and other eggs donated by the United States Government.

All of which is respectfully submitted.

B. B. REDDING,
S. K. THROCKMORTON,
J. D. FARWELL,
Commissioners of Fisheries.

SAN FRANCISCO, November 1st, 1879.

LIST OF FISH COMMISSIONERS.

UNITED STATES.		MICHIGAN.	
Prof. Spencer F. Baird	Washington, D. C.	Eli R. Miller	Richland.
ALABAMA.		A. J. Kellogg	Detroit.
Charles S. G. Doster	Prattville.	Dr. J. C. Parker	Grand Rapids.
ARKANSAS.		MINNESOTA.	
N. B. Pearce	Osage Mills.	1st District, Daniel Cameron	La Crosse.
CALIFORNIA.		2d District, Wm. W. Sweeney, M.D.	Red Wing.
S. R. Throckmorton	San Francisco.	3d District, Ormsby Sweeney	St. Paul.
B. B. Redding	San Francisco.	MISSOURI.	
J. D. Farwell	Alameda.	I. G. W. Steedman	2803 Pine Street, St. Louis.
COLORADO.		John Reid	Lexington.
W. E. Sisty	Brookvale.	Silas Woodson	St. Joseph.
CONNECTICUT.		NEVADA.	
W. M. Hudson	Hartford.	H. G. Parker	Carson City.
Robert G. Pike	Middletown.	NEW HAMPSHIRE.	
James A. Bill	Lynne.	Samuel Webber	Manchester.
GEORGIA.		Luther Hayes	South Milton.
Thomas P. James	Atlanta.	Albina H. Powers	Plymouth.
ILLINOIS.		NEW JERSEY.	
N. K. Fairbank	Chicago.	Dr. B. P. Howell	Woodbury.
S. P. Bartlett	Quincy.	Colonel E. J. Anderson	Trenton.
J. Smith Briggs	Kankakee.	Theodore Morford	Newton.
IOWA.		NEW YORK.	
B. F. Shaw	Anamosa.	R. Barnwell Roosevelt	76 Chamber St., N. Y.
KANSAS.		Edward M. Smith	Rochester.
D. B. Long	Ellsworth.	Richard U. Sherman	New Hartford.
KENTUCKY.		Eugene G. Blackford	809 Bedford Av., Brooklyn.
William Griffith, President	166 West Main St., Louisville.	NORTH CAROLINA.	
John B. Walker	Madisonville.	L. L. Polk	Raleigh.
Hon. C. J. Walton	Munfordville.	S. G. Worth	Morgantown.
Hon. John A. Steele	Versailles.	NEBRASKA.	
Hon. J. H. Bruce	Lancaster.	R. R. Livingston	Platismouth.
P. H. Darby	Princeton.	H. S. Kaley	Red Cloud.
Dr. S. W. Coombs	Bowling Green.	W. L. May	Freemont.
Hon. James B. Casey	Covington.	OHIO.	
General T. T. Garrard	Manchester.	J. C. Fisher	Coshocton.
Hon. W. C. Allen	Owingsville.	R. Cummings	Toledo.
MAINE.		L. A. Harris	Cincinnati.
E. M. Stilwell	Bangor.	PENNSYLVANIA.	
Everett Smith	Portland.	H. J. Reeder	Easton.
MARYLAND.		Benj. L. Hewitt	Holidaysburg.
T. B. Ferguson, 1327 M St., Washington, D. C.	Easton.	James Duffy	Marietta.
Thomas Hughlett	Easton.	John Hummel	Selinsgrove.
MASSACHUSETTS.		Robert Dalzell	Pittsburg.
Theodore Lyman	Brookline.	G. M. Miller	Wilkesbarre.
E. A. Brackett	Winchester.	RHODE ISLAND.	
Asa French	Boston.	Alfred A. Reid	Providence.
		John H. Barden	Rockland.
		Newton Dexter	Providence.

SOUTH CAROLINA.

A. P. Butler-----Hamburg.

TENNESSEE.

W. W. McDowell-----Memphis.

Geo. F. Akers-----Nashville.

W. T. Turley-----Knoxville.

UTAH.

A. P. Rockwood-----Salt Lake City.

VERMONT.

M. Goldsmith-----Rutland.

Charles Barrett-----Grafton.

VIRGINIA.

Colonel Marshall McDonald-----Lexington.

WEST VIRGINIA.

Henry B. Miller-----Wheeling.

Christian S. White-----Romney.

N. M. Lowry-----Hinton.

WISCONSIN.

Governor William E. Smith-----Madison.

Philo Dunning-----Madison.

J. V. Jones-----Oshkosh.

C. L. Valentine-----Janesville.

Mark Douglas-----Melrose.

John F. Antisdel-----Milwaukee.

Christopher Hutchinson-----Beetown.

H. W. Welsher-----Madison.