XI.—HISTORY OF THE TILE-FISH.

By Capt. J. W. Collins.

A.—INTRODUCTION.

1.—OBJECTS OF THE ESSAY.

In a large country like the United States, with a rapidly increasing population, everything pertaining to the subject of food for the people is a matter of public interest. As is well known, our sea-fisheries are a source from whence is drawn a large amount of the most nutritious food, which, as a rule, can be obtained by the consumer at a moderate cost. This being the case, and the fact existing that some of the most valuable species of our food-fishes are apparently being decreased in numbers to a greater or less extent by overfishing, it is not surprising that much interest should have been felt in the discovery off our coast, in 1879, of a new and valuable food-fish (*Lopholatilus chamæleonticeps*), equaling the cod in size, and occurring in great abundance in the locality where it was found. But when, in the spring of 1882, fish, chiefly of this species, were reported by incoming vessels as having been seen in countless millions floating upon the surface of the ocean in a dead or dying condition, covering thousands of square miles of the sea, it is not at all wonderful that the public interest was very much excited, and that a very general desire to learn more of this species was exhibited. The followl ing extract from an article* in the the Boston Daily Advertiser, Apri- 5, 1882, may serve as a fair example of the consideration which this subject received in the public press:

"Extensive as our list of edible fish is," says the writer, "people will gladly welcome anything new and desirable from lake, stream, or ocean. If to the standard cod, haddock, mackerel, and salmon we may add companionship of some heretofore little known, or quite unknown, fish for the further development of the general fisheries interest, both as regards labor and trade, we shall be fortunate. A living question just now is, whether or no we have a tide in the affairs of fishermen that, taken 'at the flood,' shall lead to good fortune. The excellent edible fish brought to notice by our United States Fish Commissioner not long ago, and so recently found dead and floating in immeasurable numbers upon the surface of the North Atlantic Ocean, may be the 'coming' fish. Not one to supersede the cod and its confreres, but possibly one

* Written by George E. Emory.

providentially offered to enlarge the field of gustatory and commercial possibilities. The Tile-fish found since the late tremendous commotion off our New England coast has been proved to be one of the very best sea-fish known when cooked in a fresh state. It will probably 'cure' well. The flesh is very firm in texture, keeps well, cooks nicely, and is excellent in flavor. The Tile-fish is of suitable size for easy handling in curing, packing, and trade. It exists in apparently vast if not absolutely inexhaustible numbers, along the western edge of the Gulf Stream, and probably about the eastern edge as well. * * * There is possibly in this Tile-fish matter a great opportunity for our Government Fish Commission to do work of real and permanent value, far outweighing any prior labor accomplished by the board. Let the Commissioners at once solve the problem so urgently demanding their attention. With a rapidly increasing demand for edible fish, the enhancement of prices, and the tremendous increase of capital in the country awaiting profitable investment, there ought to be no needless delay in action. How soon will the Fish Commission attempt practical work to demonstrate to commercial circles and fish eaters the practical use served by its existence? The people of the country generally want to know just where to find the Tile-fish; they want to know its habits; they want to know the best seasons and the best means for taking this valuable fish.* * * * Will the United States Fish Commission determine the facts regarding the new fish and a possible new field for fisheries as soon as may be consistent with accuracy and thoroughness?"

The object of this paper is to give, under one head and in a convenient form for reference, all that is known of the Tile-fish, and especially to place on record all the information that it has been possible to gather concerning the phenomena which occurred in the spring of 1882, when these fish were found in extraordinary numbers floating upon the surface of the ocean between Nantucket and the Chesapeake. Soon after this occurrence Professor Baird placed in my hands a large amount of data bearing on the subject, with the request that I should mark on a chart the various tracks sailed through the dead fish by the vessels which reported having seen them; and he also desired that an estimate should be made of the area covered and the probable numbers of floating *Lopholatilus*. Before, however, my other duties permitted the accomplishment of this work, circumstances placed me in a position to acquire much additional knowledge concerning the earliest captures of this fish, besides many other facts which appeared to be more or less

* As will be seen in succeeding paragraphs, Prof. Spencer F. Baird sent out an expedition to the Tile-fish grounds as early as 1880, but, unfortunately, this failed to accomplish its purpose. Another investigation, made by the author in the fall of 1882, under the direction of Professor Baird (a report of which has already been published), failed to obtain any information concerning the *Lopholatilus*, which, at this time, was probably so much depleted by the mortality of the previous spring that none remained on the ground where it had formerly been found.

interesting in this connection. All of this knowledge has been combined with other material at hand, and though necessarily much of this essay must be a compilation, the writer simply supplying the threads to bind together the material which has been gathered from so many sources; it is, nevertheless, hoped that the manner of presenting these facts may make them of some value to those interested in the subject under discussion.

B.—GENERAL CHARACTERISTICS OF THE TILE-FISH.

2.—DESCRIPTION OF THE FISH, WITH NOTES ON ITS CLASSIFICATION.

The Tile-fish has many peculiarities of its own, and, even to the casual observer, presents features which differ essentially from those possessed by any other species found near the same locality. In size it varies from five to fifty pounds; its head is proportionately large, and has a general resemblance to that of the dolphin (*Coryphæna*), and also to that of the wolf-fish (*Anarrhichas*), though differing from both; the body is well formed, quite stout at the tail, like the salmon, and the general make-up of the fish indicates that it is a rapid and active swimmer, well fitted to pursue and capture its food or to escape from its enemies. Its distinguishing characteristics, however, are the nuchal crest or adipose dorsal fin just in front of the spinous dorsal, and the peculiar color which it exhibits, being so profusely spotted with patches of greenish-yellow, that it received the name of "Leopard-fish" from the fishermen who were the first to capture it.

"The liver," says Captain Dempsey, "is small, somewhat like that of the mackerel, and contains no oil. The flesh is oily, and will soon rust after splitting and drying.

"The stomach and intestines are small, the latter resembling those of an eel.

"The swim bladder is similar to that of a cod.

"Some of the fish 'blister' like cusk when taken on deck."*

According to Captain Dempsey, Tile-fish, when caught on hand-lines, are fully as active in their movements as cod, and appear even more lively than the latter species when taken on deck. Captain Kirby, however, who caught them on trawl-lines, says they exhibit less activity than the cod.

The following scientific description of the *Lopholatilus chamæleonticeps* Goode and Bean, was published in the Proceedings of United States National Museum, Vol. 2, pp. 205–208:†

"A few days ago Capt. William H. Kirby, of Gloucester, Mass., took 500 pounds of a remarkable new fish on a codfish trawl in latitude 40°

* Statement of Capt. William Dempsey, Proc. U. S. Nat. Museum, vol. 2, pp. 208, 209.

† Description of a new genus and species of fish, *Lopholatilus chamæleonticeps*, from the south coast of New England, by G. Brown Goode and Tarleton H. Bean.

N., longitude 70° W., at a depth of 84 fathoms, 80 miles south by east of Noman's Land. One of these was forwarded by him to the United States National Museum, and forms the type of a new genus and species. The single individual secured (No. 22899, Earll 342) is 33 inches long. The largest one taken, according to Captain Kirby, weighed 50 pounds.

"The species appears to be generically distinct from the already described species of the family *Latilidæ* Gill. It is related by its few-rayed vertical fins and other characters to the genus *Latilus* as restricted by Gill, but is distinguished by the presence of a large adipose appendage upon the nape, resembling the adipose fin of the salmonidæ, and by a fleshy prolongation upon each side of the labial fold extending backwards beyond the angle of the mouth. For this genus we propose the name *Lopholatilus*.

"LOPHOLATILUS CHAMÆLEONTICEPS, sp. nov.

"DESCRIPTION.—The greatest height of the body (.306), which is at the ventrals, is contained about three and one-half times in the length to the origin of the middle caudal rays, and four times in the extreme length. Its greatest width (.144) equals the length of the caudal peduncle (.144); this latter being measured from the end of the soft dorsal to the origin of the middle caudal rays. The least height of the tail (.0867) is contained four times in the distance of the spinous dorsal from the snout.

"The greatest length of the head (.33) is contained three times in the length to the origin of the middle caudal rays. Its greatest width (.165) is slightly more than twice the width of the interorbital area (.08). The length of the snout (.122) is contained twice in the length of the pectoral of the right side (.244). The length of the operculum to the end of the flap (.11) is one-ninth of total length. The length of the upper jaw (.15) equals one-half of the height of the body at the ventrals, and is contained two and one-half times in the length of the head. The maxilla extends to the perpendicular through the anterior margin of the orbit; the mandible does not quite reach the perpendicular through the middle of the orbit; the length of the labial appendage is slightly more than half of the long diameter of the orbit and one-third of the length of the first pectoral ray. The length of the mandible (.156) slightly exceeds the distance from the snout to the orbit (.15), and equals three times the long diameter of the eye (.052), which is contained six and one-half times in the length of the head. The operculum and preoperculum are scaly; the latter is finely denticulated on its posterior margin. The distance of the posterior nostril from the eye equals the length of the first anal spine; the distance between the anterior nostril and the end of the snout is twice as great. The intermaxillaries are supplied with an outer series of nineteen canine teeth, and behind these a band of viliform teeth, widest at the symphysis; vomer and palatines toothless.

"The distance of the adipose dorsal from the snout (.206) equals nearly three times its height (.07); its length of base (.123) equals the length of the snout. The height of the adipose dorsal equals the distance from the tip of the ventral to the vent.

"The distance of the spinous dorsal from the snout (.347) equals the distance of the ventral from the snout (.347); its length of base (.144) equals the length of the caudal peduncle. The first spine is imperfect—what remains of it is one-third as long as the third spine (.09). The second spine (.082) is about equal to the width of the interorbital area. The fourth and the sixth spines are equal in length (.097), and equal the distance from the end of the snout to the posterior nostril. The fifth spine (.095) is a little shorter than the sixth. The last spine (seventh) is contained ten times in the total length. The length of the first ray of the soft dorsal (.094) equals the distance between the anterior nostril and the end of the snout. The thirteenth and longest ray (.147), about equals the length of the base of the spinous dorsal. The last ray (.07) is half as long as the thirteenth. The thirteenth ray of the soft dorsal extends to the origin of the external caudal rays.

"The distance of the anal from the snout (.60) is about equal to twice the height of the body at the ventrals. The length of the anal base (.318) is slightly more than twice the length of the mandible. The first anal spine (.04) is half as long as the second dorsal spine. The second anal spine (.075) is half as long as the upper jaw. The first ray of the anal (.102) is as long as the last spine of the dorsal. The eleventh and longest anal ray (.134) is contained seven and one-half times in the total length, and nearly equals the length of the middle caudal rays. The last anal ray (.078) is half as long as the mandible. The eleventh ray of the anal extends almost to the perpendicular through the origin of the middle caudal rays.

"The caudal is emarginate, the external rays being only one and one-half times as long as the middle rays. The length of the superior external rays (.216), measured from the origin of the middle rays, equals one and one-half times the length of the spinous dorsal base.

"The distance of the pectoral from the snout (.32) very slightly exceeds the length of the anal base. The length of the pectoral of the right side (.244) equals twice that of the snout. The pectoral of the left side is probably imperfect, its length (.216) being equal to that of the superior external caudal rays. The right pectoral can be made to reach the vent; in its natural position it extends to the perpendicular let fall from the fourth ray of the second dorsal.

"The distance of the ventral from the snout (.347) equals four times the least height of the tail. The length of the ventral (.183) equals twice that of the third dorsal spine, and it extends to a point under the third dorsal ray. The distance from the tip of the ventral to the vent equals half the length of the middle caudal rays. The vent is under the interval between the fourth and fifth dorsal rays.

"*Radial formula.*—B. VI; D. VII, 15; A. II, 13; C. 18; P. II, 15; V. I, 5; L. Lat., 93; L. Trans., 8 + 30.

"*Color.*—The operculum, preoperculum, upper surface of head, and major portion of the body have numerous greenish-yellow spots, the largest of which are about one-third as long as the eye. Upon the caudal rays are about eight stripes of the same color, some of them connected by cross-blotches. The upper part of the body has a violaceous tint, and the lower parts are whitish, with some areas of yellow. The anal and ventral fins are whitish. The pectorals have the tint of the upper surface of the body, with some yellow upon their posterior surfaces. The soft dorsal has an upper broad band of violaceous, and a narrow, basal portion of whitish. Many of the rays have upon them a yellow stripe; there are some spots the same color, especially upon the anterior portion of the fin.

"NOTE.—In the table of measurements the unit of comparison is the length to the origin of the middle caudal rays."

Table of measurements.

Current number of specimen	22889
Locality	80 miles S. by E. of Noman's Land.
	Millimeters.	100ths of length.
Length to orgin of middle caudal rays	692	.....
Length to end of middle caudal rays	788	.....
Body:		
Greatest height (at ventrals)	212	30.6
Greatest width	100	14.4
Least height of tail	60	8.67
Length of caudal peduncle	100	14.4
Head:		
Greatest length	230	33
Greatest width	114	16.5
Width of interorbital area	56	8
Length of snout	85	12.23
Length of operculum	77	11
Length of upper jaw	105	15
Length of mandible	108	15.6
Distance from snout to orbit	103	15
Long diameter of eye	36	5.2
Dorsal (adipose):		
Distance from snout	143	20.66
Length of base	85	12.28
Greatest height	48	7
Dorsal (spinous):		
Distance from snout	240	34.88
Length of base	100	14.4
Length of first spine (possibly broken)	20	3
Length of second spine	57	8.24
Length of third spine	63	9.1
Length of fourth spine	67	9.68
Length of fifth spine (possibly broken)	66	9.54
Length of sixth spine	67	9.68
Length of seventh spine	70	10
Dorsal (soft):		
Length of base	300	43.35
Length of first ray	65	9.4
Length of longest ray (thirteenth)	102	14.74
Length of last ray	48	7
Anal:		
Distance from snout	416	60
Length of base	220	31.79
Length of first spine	29	4.2
Length of second spine	52	7.5
Length of first ray	71	10.26
Length of longest ray (eleventh)	93	13.44
Length of last ray	54	7.8

Table of measurements.

	Millimeters.	100ths of length.
Caudal:		
Length of middle rays	96	13.87
Length of external rays.. { superior	150	21.67
Length of external rays.. { inferior	145	21
Pectoral:		
Distance from snout	223	32.22
Length.. { right side	169	24.42
Length.. { left side	150	21.67
Ventral:		
Distance from snout	240	34.68
Length	127	18.35
Branchiostegals	VI	.....
Dorsal	VII, 15	.....
Anal	II, 13	.....
Caudal	18	.....
Pectoral	II, 15	.....
Ventral	I, 5	.....
Number of scales in lateral line	93	.....
Number of transverse rows above lateral line	8	.....
Number of transverse rows below lateral line	30	.....

3.—SYSTEMATIC RELATIONS OF LOPHOLATILUS.

The Tile-fish is a member of the family *Latilidæ*, as classified by Gill, and is most nearly related to the typical genus known as *Latilus*. Other representatives of the family are *Caulolatilus*, *Prolatilus*, and *Pinguipes*. These forms, except *Lopholatilus*, are more especially inhabitants of the tropical and warm seas, but some range both to the northward and southward of the equatorial belt. In detail, the genus *Latilus* is composed of species found in the Chinese and Japanese seas. *Caulolatilus* is confined to the warm waters on both sides of the American continent; *Prolatilus* has a single species, which has hitherto been found only on the Chilean coast, and of *Pinguipes*, there is a species dwelling in the temperate or less heated waters on both sides of South America. *Lopholatilus* is exceptional in its distribution, in that it inhabits deep water in a nearly uniform temperature of about 50 degrees, the variations, according to the observations taken on United States Fish Commission steamer Fish Hawk, being from 42° to 50° Fahr.

All the other forms occur in water of comparatively little depth and near the coast; are apparently moderately abundant in their special regions, where they are considered quite good food-fishes, as a rule, though they do not at all rival the Tile-fish in size.

4.—HABITS; ABUNDANCE; EXTENT OF THE LOPHOLATILUS BANK.

Habits.—Comparatively little can be said of the habits of the Tile-fish. The locality where it has been found is so rarely visited by our cod-fishing vessels that it may be considered the merest chance that the schooners William V. Hutchings and Clara F. Friend went there in 1879. Consequently nothing can be learned from the fishermen beyond the accounts given by Captains Kirby and Dempsey. Comparatively little, too, has been learned by the Fish Commission concerning the habits of this species,

during the past two years, 1880–'81, as I am informed by Dr. Tarleton H. Bean, who had charge of the Department of Fishes. Writing under date of July 10, 1882, he says:

"The amount of knowledge possessed by the United States Fish Commission concerning the food and spawning habits of *Lopholatilus* is small indeed. I do not remember any information about the spawning. Last year we took a good many individuals on the trawl-line and found them gorged with a large species of amphipod crustacean, *Themisto bispinosus* This is all I know about the food; am sorry it is so little."

In regard to the lack of knowledge concerning the spawning, alluded to by Dr. Bean, it may be said that Tile-fish have been taken by the Fish Commission only in August and September, when it is probable that the season of reproduction had passed, since Captain Dempsey says that the fish which he took in June, 1879, were fully ripe and that their eggs ran from them.

The food of *Lopholatilus*, according to Captain Kirby, consists chiefly of crabs of various species, with which the stomachs of the fish he caught in 1879 were filled to repletion. It bites eagerly, however, at fresh menhaden bait, and very likely, at certain seasons, it may feed largely on some species of small fish. Captain Dempsey did not notice any food in the Tile-fish which he caught, but this was due, no doubt, to lack of observation on the part of those who eviscerated them.*

Lopholatilus is evidently a "ground-feeder," like the cod, since it has generally been caught on trawl-lines set at the bottom. Captain Dempsey is of this opinion, and says those he caught on hand-lines were hooked close to the bottom. Captain Kirby, however, thinks they do not remain at the bottom, but "play" up in the water, notwithstanding those he caught were taken on a trawl-line. He was led to form this opinion because the larger part of the fish he captured were on that portion of his gear which, he thought, did not reach the bottom.

In all probability the *Lopholatilus* is essentially a deep-water fish, though our knowledge of it is yet too limited to speak with any degree of certainty on this subject. At the present time it is impossible to say in what depths it may be found in other localities. We only know that it has been taken in from a little less than 90 to 134 fathoms. The area, however, covered by the dead fish in the spring of 1882, a discussion of which is given in another paragraph, would indicate that this species had a much wider range, in regard to depth, than would appear from the captures made on hook and line.

As to the seasons when they frequent the waters off the southern coast of New England, we also know comparatively little. Whether

* I am told by Mr. Richard Rathbun, that on the first trip on which *Lopholatilus* were taken by the United States Fish Commission steamer Fish Hawk, three specimens were caught, in the stomachs of which were found bones of mutton chops that had been eaten at breakfast on board the steamer. This would indicate that the Tile-fish is quite as voracious as the cod.

they remain during the winter in the region where they have been found in the summer cannot be said. The fact that they were seen floating upon the surface, dead or dying, early in March, 1882, would indicate, at least, that they are on the ground in the latter part of the winter, and as they have been caught on trawls as late as the 13th of September, it is probable that they might remain some weeks longer, if not all the year.*

In regard to other peculiarities, Captain Kirby says that these fish when hauled from the water, do not flap their tails as the cod do under similar circumstances, but seem to be paralyzed. Even when being unhooked they do not make any muscular effort. This is so entirely different from the account given by Captain Dempsey, who caught the Tile-fish on hand-lines, that I feel compelled to notice it, but must ascribe the conflicting statements not to any lack of attention on the part of these observers, but to the fact that the movements of the same kind of fish taken on hand-lines often differ radically from those caught on trawls, since on the latter apparatus they are supposed to exhaust themselves in their continued struggles to escape, so that they frequently drown before the gear is hauled. This is especially noticeable in catching the halibut. One of these on a hand-line will give the strongest fisherman all he can do to haul the gamey fish to the surface, and it almost always happens that the line must be veered out several times or the gear would be torn in two by the active and powerful fish. But caught on a trawl the halibut rarely shows much fight, except in very shoal water, and not unfrequently a doryman will be pulling at once from fifteen to forty of these fish, either one of which, if hooked on a hand-line, would give him all he could do to manage it, and bring it successfully along side.

Abundance.—Whatever may be the numerical strength of the Tile-fish at the present time, it is beyond question that this species occurred in vast numbers in the waters bordering the Gulf Stream—between Hatteras and Nantucket—previous to the season of 1882, though comparatively little was known in regard to their actual abundance, or the extent of the area where they could be taken. It is true that Captain Kirby had found them so numerous that large catches might have been made on trawls; Captain Dempsey caught them "pair and pair" on hand-lines, and the Fish Commission, during its investigations off the Southern New England coast, had taken more or less of them on sev-

* This refers to the habits of the Tile-fish previous to the great mortality in the spring of 1882. Since that time the investigations made by the Fish Commission steamers Fish Hawk and Albatross and a special cruise made in the smack Josie Reeves, for the purpose of finding *Lopholatilus*, all of which failed to secure a single individual of this species, it seems probable that the survivors, if there were any, have abandoned the locality where they had been previously so abundant. Speculations, therefore, as to their movements, the time they remained on certain grounds, &c., can only apply to that period when they were known to be plentiful in the spring and summer, at least, off the coast of New England.

eral occasions. Nevertheless, we had no adequate idea of their abundance, nor indeed of their importance, until they were observed floating upon the surface of the sea in such masses that even with the most liberal reductions for possible exaggeration on the part of the observers, the mind is confused in calculating the figures which would denote their numbers.

There can be but little doubt that the habitat of the Tile-fish covered a large area, equal in size to some of the most important of the favorite haunts of the cod, and that the fish themselves existed in an abundance nearly approaching to that of the last-named species; but whether or not *Lopholatilus* may be found at present in abundance farther south than it has been taken heretofore is an open question. There seems to be but little reason to doubt the probability of their occurrence in such localities as may be congenial to them for many hundreds of miles along our Southern coast; for, according to the best authorities, its relatives are subtropical species, and it would be likely to occur in Southern waters.

Extent of the Lopholatilus bank.—If we were obliged to confine ourselves simply to the consideration of the area where *Lopholatilus* has been taken on hook and line we would find a range of limited extent stretching along the slope inside of the Gulf Stream, about the parallel of 40° N. lat., and from 70° to about 71° 25′ W. long., in depths varying from about 90 to 125 fathoms. This ground is some 65 miles in length with an average width of, perhaps, 3 to 4 miles. But the dead Tile-fish which were seen floating upon the surface of the ocean in the spring of 1882 gives us a far better conception of the area covered by this species. From a careful consideration of the large amount of data which has been at my disposal I find that these fish were noticed over an area 170 miles in a northeasterly and southwesterly direction, and with an average width of at least 25 miles. This shows them to have covered an area of 5,620 square statute miles, even after making liberal allowances for the drift of the fish by winds and currents. Within this region, then, lying between the parallels of 37° 29′ and 40° 00′ N. lat. and meridians of 69° 51′ to 74° 00′ W. long., we may safely say, is the *Lopholatilus* bank. That this is the only region where these fish occur is not at all probable, and it seems altogether likely that future investigations may demonstrate that the area here spoken of is but a portion of the ground where this species may be found. The researches of the United States Fish Commission have demonstrated the fact that along the slope lying inside of the Gulf stream, between the parallels of 37° and 40° N. lat., and in depths ranging from 80 to about 200 or 250 fathoms there is a band of warm water extending to the bottom of the sea, while inside of it, in shallow water, the temperature is much lower, and at the bottom, in greater depths, beneath the warm waters of the Gulf stream, a cold stratum is also found. This belt of warm water, which seemingly just sweeps the ocean bed in the

locality mentioned, is the home of an immense amount and variety of sea life, among which occurs many tropical and subtropical species, and here also is found the Tile-fish. A full discussion of this subject from the pen of Prof. A. E. Verrill, of Yale College, will be found in a following section of this paper.

5.—USES AND UTILIZATION.

That *Lopholatilus* is a good and wholesome food-fish has been settled by competent authority; though, curiously enough, those who have partaken of it seem to disagree in regard to their estimate of its quality and flavor. Many of these persons say without hesitation that it is one of the finest, if not the best flavored, fish they have ever eaten, while others consider it not especially good in this particular. This species of fish, like some others, the Pompano, for instance, is said to have a flavor peculiar to itself, which to some people is extremely agreeable, while to others it is not so pleasant. From what is known of the Tile-fish it is altogether probable that it would be best relished in a fresh condition, and there is reason to suppose that in case it could be taken in large quantities it might occupy a very prominent position in the fish markets of our sea-coast towns. It might, perhaps, also be a valuable article of food salted and preserved in brine, as are mackerel, but owing to the presence of fat in the flesh it has not been found practical to cure it in the same manner as salted codfish are prepared for market. In the summer of 1879, Capt. George Friend, of Gloucester, smoked some of the tile-fish which were taken by Captain Kirby, and he, as well as several others who ate them, told me that they were excellent when prepared in this manner, rivalling smoked halibut in richness and flavor. On the other hand, Mr. William H. Wonson, 3d, who also smoked the Tile-fish at Gloucester, does not speak so highly of its fine qualities as a food-fish under the same conditions. He says that while it is certainly very good and wholesome, as well as a desirable article of food when smoked, it cannot compete with the halibut, and is no better, in fact, than smoked haddock—the finnan haddies.

Without doubt, the best way of utilizing the catch of the Tile-fish, which possibly may hereafter be found in the localities where they were formerly abundant (off the coast between Nantucket and the Chesapeake), would be to ice the fish, and take them in a fresh condition to the New York and Philadelphia markets, since these ports are in close proximity to the fishing-grounds and could be easily reached while the fish were in good order. Two or three days' work at most would suffice, under ordinary circumstances, to secure a good fare, and one of our swift-sailing fishing-vessels could make the voyage from the Tile-fish grounds to either New York or Philadelphia in from ten to twenty hours, unless the chances were specially unfavorable. Considering that haddock and cod are now brought in a fresh condition to Boston market from Le Have and Western Banks, a distance ranging from 300

to 450 miles, during the winter season, it certainly would be feasible to bring fresh Tile-fish to market over a much shorter distance. That they can be smoked and thus be made an excellent article of food, and that the presence of a certain amount of fat or oily matter in the flesh tends to make them very desirable when prepared in this manner, is a sufficient guarantee that any surplus, however large or small, may be profitably disposed of. Should the Tile-fish ever visit our coast in the future in as great abundance as heretofore, it is more than probable that the fishery for it might be prosecuted with profit to the fishermen, and also that the New York and Philadelphia markets might be supplied at all seasons of the year with this additional and excellent food-fish.

C.—HISTORY OF ITS DISCOVERY AND SUBSEQUENT CAPTURE.

6.—ACCOUNT OF ITS DISCOVERY BY CAPTAIN KIRBY.

The first capture of Tile-fish, as has been stated, was made by Captain Kirby, in May, 1879, while trawling for cod to the southward of the South Shoal of Nantucket, and to him, therefore, belongs the honor of obtaining and presenting to the United States Fish Commission the individual specimen which forms the type of this species. In the description of *Lopholatilus*, already quoted, reference is made to this circumstance, but for obvious reasons it is deemed unnecessary to repeat it here. A more detailed account of this capture of the Tile-fish, together with the causes which led thereto, may, however, prove of interest, and is therefore given on data furnished by Captain Kirby.

In the spring of 1879, one of the halibut schooners that had been fishing in the deep water to the southward of the South Channel and George's Bank, reported an abundance of hake (*Phycis chuss* and *P. tenuis*) in that region. Captain Kirby heard of this rumor, but his informant told him that the locality where these hake were taken was to the southward of the South Shoal of Nantucket. The reported abundance of these fish received at that time more than ordinary attention from the fishermen, since the extreme high price then paid for hake sounds—swim bladders—together with the large yield of oil obtained from the livers, added to the worth of the fish for food purposes, rendered its pursuit and capture an object of unusual importance. Influenced by these considerations, Captain Kirby, who had been engaged in cod-fishing on the banks north of Cape Cod during the spring, decided to investigate the matter and to learn by actual trial whether or not the rumor was based on fact. Accordingly he proceeded to Greenport, Long Island, and having obtained there a good supply of fresh menhaden for bait, he started for the fishing-ground.

Passing out between Montauk Point and Block Island he ran off on a south southeast course about 68 miles, where a depth of 80 fathoms was obtained, the position being lat. 40° 07′ N., long. 70° 59′ W.

Having reached this locality, which was supposed to be a favorite one for hake, a "set under sail" was made.* No favorable results being obtained on this and another set of the trawls which was made the same day to the northwest of the first, in shoaler water, and the weather remaining moderate and clear, the vessel was allowed to head to the eastward during the night, sailing slowly in that direction. As it was moderate, she probably did not go more than 20 or 25 miles.

On the following morning another set was made in the same manner as before, four trawls, each having 1,000 hooks, being put out. The first ends of the lines were thrown out in about 80 fathoms, from which they were run in a southerly direction. The length of each of the trawls was a little more than a mile, and, having been set where the bottom slopes quite rapidly towards the deep valley of the Gulf Stream, it was found when the gear was hauled that, though the buoy-lines on the outer or deep-water ends were each 120 fathoms long, a portion of the trawls had not reached the bottom. This set was made in lat. 40°, 04′ N., long. 70°, 23′ W.

One of his men being too ill to work Captain Kirby went out in a dory himself to assist in hauling the gear, leaving the cook in charge of the schooner. He (Kirby) says that little was caught on the portion of the trawls set in the shoalest water, but on about one-fifth of their length—that part set last, some of which, as previously mentioned, did not reach the bottom, being, as Captain Kirby thinks, in about 150 fathoms—a strange and handsomely-colored fish was taken in great abundance, each of the dories securing a catch of thirty or forty indi-

* The term "set under sail," or "flying set," implies that the vessel, instead of being anchored, as is the most common way on the Banks when trawls are to be set, is kept under way, the performance taking place as follows:

The depth of water having been first ascertained by the skipper, he then orders the dories to be made ready. This puts all hands on the alert, especially the crews of the top dories, who quickly arrange in them the buoys, buoy-lines, etc., that are required. Having made all necessary preparations, the top dories are hoisted over the rail, where they are left to hang until the next are ready, when they are lowered into the water. The trawls are then put in and the men take their places in the dories, when the boats are dropped astern, the painters being fastened to the stern of the vessel. In the same manner the other dories are prepared and hoisted out.

When all are ready, and the proper time has arrived, the vessel usually stands along by the wind, dropping first one dory and then another about one or two hundred fathoms apart, when the men in them proceed to set the trawls in the usual manner, generally rowing the dories to leeward in a direction nearly at right angles to the vessel's course.

The first dory's crew are usually almost done with their work by the time the vessel has dropped the last boat. The schooner then keeps off and runs down to pick up the first and the other boats in succession, as they each finish setting their gear. This done, she lies by until it is time to haul, when the vessel is run along from buoy to buoy, dropping each dory near its own trawl. The men in the boats then proceed to pull in their lines, the vessel in the mean time lying by waiting, or running from boat to boat to ascertain what success they meet with. The holding up of an oar is a signal that the men have finished hauling their trawl or want help, seeing which the vessel runs down and receives the cargo or takes the boat in tow.

viduals, equal to a total of nearly 2,000 pounds, all of which, however, with the exception of a few specimens, saved as a curiosity, were thrown away. The weather continuing fine, with light winds, two more sets were subsequently made under sail, the first of these about 3 to 4 miles (lat. 40° 04′ N., long. 70° 17′ W.), and the last some 10 or 12 miles in an easterly direction from the position where the Tile-fish were first taken. On each of these trials some of the *Lopholatilus* were caught, though the chief part, however, were taken on the last haul in the deepest water reached by the trawls, ranging from 100 to 130 fathoms, the position being lat. 40° 00′ N., long. 70° 04′ W.

In the mean time Captain Kirby had some of the new fish cooked, and as they were (as he says) the finest fish he ever ate, he decided to save and salt all that he might take thereafter. Accordingly, those caught on the two last-mentioned sets were split and salted in kench, like codfish, a single specimen only being saved in ice.

Not having met with satisfactory success in taking cod or hake in the trials above described, few or none of these species having been caught, Captain Kirby went farther to the eastward, and finally anchored in a depth of 120 fathoms south by east from the light-ship on the South Shoal off Nantucket, in which locality no Tile-fish were captured.

On the arrival of the vessel in port, the salted *Lopholatilus*, about 2,000 pounds in all,* were sold to Messrs. George Friend & Son, who smoked a portion of the fish and disposed of the remainder as opportunity offered, giving away, however, many of them to neighbors and acquaintances.

7.—ACCOUNT OF THE CAPTURE OF TILE-FISH BY CAPTAIN DEMPSEY.

In the published description of *Lopholatilus* is also the following notice of a second capture of this species by the schooner Clara F. Friend, Captain Dempsey, of Gloucester, which occurred a short time subsequent to that which has just been described.

"Capt. William Dempsey, of Gloucester, has since furnished nine fresh specimens of this *Lopholatilus*, and the following information:

"'The fish were caught with menhaden bait, in July, 1879, while

* It will be noticed that there is a decided difference in the amount of Tile-fish said to have been taken by Captain Kirby in the published account already quoted and that given here. I am satisfied, however, that the latter is the most nearly correct, since the statements obtained from Mr. Friend relative to this matter coincide with those made by Captain Kirby. Taking into consideration, therefore, that these fish, in a salted condition, did not weigh much more than two-thirds the amount that they would have weighed when fresh, and also including the 2,000 pounds which were thrown away, it will be seen that a total of at least 5,000 pounds of Tile-fish were caught on *only a small portion* of 4,000 hooks that were set three times. The great abundance of the *Lopholatilus* in that locality in 1879 is, therefore, apparent. It is altogether probable that a vessel setting 12,000 hooks, which is about the average number, and placing those to the best advantage on the Tile-fish ground, would have taken anywhere from 15,000 to 20,000 pounds on a single set of the trawls.

"trying" for cod 50 miles south by east of Noman's Land, in lat. 40° 10′ N., long. 70° 55′ W., 75 fathoms, on very hard clay bottom. Two miles inside of this bottom there is nothing but green ooze, on which no fish will live.

"'Two of the nine fish were spent females. The few remaining eggs of these two were not so large as those of the herring, and resemble the eggs of the Norway haddock. The other seven had nothing to determine whether they were male or female.'"*

The following additional details concerning the taking of the Tile-fish by Captain Dempsey are given on the authority of statements made by him:

Being engaged in the George's hand-line codfishery for which menhaden is the most desirable bait, in summer, Captain Dempsey, in July, 1879, visited Newport, R. I., for the purpose of securing a supply of this needful article. This having been obtained, he ran off from Beaver Tail on a south-southeast course, a distance of about 140 miles, where he sounded, but got no bottom. Feeling desirous of "trying the ground" in order to ascertain if any cod, hake, &c., could be taken in this little known region, he stood back to the northwest until he sounded in 87 fathoms, his position being lat. 40° 02′ N., long. 70° 07′ W. The vessel was hove to and three of the crew put out their hand-lines to "try" for cod.†

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*Proc. U. S. National Museum, Vol. II., pp. 208, 209.

It seems desirable to call attention here to the discrepancy that appears (in giving the locality where these fish were caught) between the position indicated by the latitude and longitude given, and that which the course and distance from Noman's Land would place the vessel in. The two statements, though evidently intended to point to the same place, give us two positions which are separated at least 30 miles. This is, without doubt, due to an error of information, and would, perhaps, hardly deserve particular notice, were it not that a careful investigation of the matter, together with the advantage of consulting a chart used at the time, by Captain Dempsey, convinces me that both of these positions are erroneous to a greater or less extent. Of course, in forming this opinion, I depend wholly on the information furnished by Captain Dempsey, who has, in my presence, carefully laid out the course and distance which he ran after taking his departure from the land, and has marked the position where he found the Tile-fish so abundant.

A difference will also be noticed between the depth of water (75 fathoms) given in the published statement, and that (87 fathoms) which Captain Dempsey now remembers to have taken the *Lopholatilus* in. Captain Dempsey is positive that he took the fish in the greatest depth mentioned, and this seems all the more probable, since it agrees with the observations made by Captain Kirby, and also by the United States Fish Commission, neither of them having been able to find Tile-fish in water as shoal as 75 fathoms.

†Under such circumstances a "trial" is made in the following manner, namely: The main-sheet is eased off and the boom hauled out by a tackle, the jib is then hauled down, the fore-sheet slacked away as required, and the helm put hard down. Unlike the mackerel schooner, which always lays to on the starboard tack, the cod hooker is hove to on whichever tack she happens to be on, or on which she will head the current and make the best drift.

As soon as the headway of the vessel stops the lines are baited and put out, the fishermen always standing at the rail on the weather side of the deck.

"As soon as the leads struck the bottom," says Captain Dempsey, "each man caught either a pair or a single fish, such as we had never seen before, and which, from their manner of biting and their movements while being hauled, we supposed were cod until they were brought to the surface of the water alongside of the vessel.

"We put our lines out a second time with the same result, obtaining in all nine of these fish, which we gutted and packed in ice.*

"As there was no indication of the presence of codfish (indeed we caught nothing but Tile-fish), we left the locality and proceeded to the fishing-grounds with which we were more familiar, and where we completed our fare."

8.—CAPTURES MADE BY THE UNITED STATES FISH COMMISSION.

During the summer of 1880 the United States Fish Commission established its headquarters at Newport, R. I., and the following year its summer station was at Wood's Holl, Mass. Both seasons extensive explorations were made by the Fish Commission steamer Fish Hawk of the sea bottom lying off the south coast of New England, on the inner edge of the Gulf Stream slope, in depths varying from 70 to 700 fathoms.

Very important results were obtained in these researches, of which it is not necessary to speak at length here any further than relates to the subject under consideration. On several occasions many of the Tile-fish were taken on a trawl-line. Professor Verrill, writing in the fall of 1881, says: "'It seems to be very abundant over the whole region explored by us in 70 to 134 fathoms. On one occasion a 'long-line' or 'trawl-line' was put down at Station 949† in 100 fathoms, and 73 of these fishes were taken, weighing 541 pounds."‡

August 9, 1881, eight individuals were caught on a trawl-line in lat. 40° 01′ N., long. 71° 12′ W., the depth being 134 fathoms; bottom, sand and mud; surface temperature, 69°; bottom, 50°.

September 13, 1880, three Tile-fish were caught on muddy bottom in 126 fathoms, lat. 39° 56′ N., long. 70° 54′ W. Surface temperature, 71°; bottom, 50°.

9.—FAILURE OF THE EXPEDITION SENT TO THE TILE-FISH GROUNDS IN 1880.

So desirous was Professor Baird to obtain fuller knowledge of *Lopholatilus*, which had been pronounced an excellent food-fish, that during his stay in Newport in 1880 he chartered a Noank fishing smack, the Mary Potter, 44 tons, with her crew, to visit the Tile-fish grounds and ascertain in a practical way the abundance of these fish, and, so far as

* These were the specimens mentioned as having been obtained by the United States Fish Commission.

† August 23, 1881, lat. 40° 03′ N., long. 70° 31′ W.; depth, 100 fathoms; mud; surface temperature, 66°; bottom, 52°.

‡ *Notice of the remarkable Marine Fauna occupying the outer banks of the Southern coast of New England*, No. 2, by A. E. Verrill. American Journal of Science, Vol. XXXII, October, 1881, p. 295.

possible, the extent of the area of their occurrence. Two members of the United States Fish Commission, Mr. Vinal N. Edwards and Mr. Newton P. Scudder, also went on the smack. No satisfactory investigation was made, however; for the captain, fearing that he would be caught out in a storm, which he thought was imminent, returned to port without having secured a single specimen of *Lopholatilus*, or, indeed, without having made any determined or persistent effort to accomplish the object of the expedition.

The following account of the cruise has been furnished by Mr. Edwards, and presents in detail all that occurred during the trip:

"September 29, 1880, we left Newport, R. I., at 5 o'clock a. m. in the smack Mary Potter, Captain Potter master, with a crew of four men, and Mr. Scudder and myself. The wind was strong from the westward, and, after we had run off about south southeast from Block Island, it increased in strength and hauled to the northwest. We then took in the foresail, tacked ship, and stood back towards Block Island, under which we anchored at 5 o'clock in the afternoon. Here we lay all night, the wind in the meantime blowing strong from the northwest. On the morning of September 30 the weather was clear, and wind still fresh from the northwest. At 7 o'clock a. m. we got under way, and ran offshore under the three lower sails on a south by east course. At 5 o'clock p. m. we took in the foresail, and hove to and sounded, getting a depth of 80 fathoms. We lay to until daylight on the next morning, when the wind moderated very rapidly, becoming calm in three hours. Having sounded at dawn in 95 fathoms, we ran south for two hours, when we found a depth of 127 fathoms. Here we sat a trawl of 400 hooks, baited with menhaden, and left it out three hours. When hauled, we got on it one swordfish, weighing 500 pounds, and two skates, but nothing else. After hauling the trawl we ran to the eastward, expecting to set again, but the wind breezed up from the northeast, and looked as if there was going to be a blow, and, possibly, a gale, from that direction. Therefore, the captain thought it best to run for Block Island, and we accordingly stood in by the wind for the land, heading along about north northwest until 12 o'clock midnight, when the wind moderated and veered to the eastward. On the morning of October 1, which was nearly calm, we went off in a boat and caught some crabs, shrimp, and small fish. At 9 o'clock the wind sprang up from east southeast, and at 11 o'clock we made Block Island. We then ran for Newport, where we arrived at midnight."

D.—THE MORTALITY AMONG THE TILE-FISH.

10.—THE DEAD FISH.

The reports brought in by vessels arriving at the principal Atlantic sea-ports during the months of March and April, 1882, of great numbers of dead fish having been seen floating at the surface of the sea, over an

extensive area inside of the Gulf Stream, between the latitudes of the Chesapeake and Nantucket, created a widespread public interest. Such a phenomena had never before been known to occur off the northeastern coast of the United States, and the various phases of this wonderful event received much attention from the press, which recorded a great deal of information concerning this remarkable mortality among the fishes.

The following, which is one of the earliest notices of dead fish having been seen floating upon the surface of the ocean to the southward of Nantucket, appeared in the Boston Advertiser of March 21, 1882. It will be observed that the victims of the extraordinary fatality which is here described were supposed to have been codfish:

"It was reported yesterday that the Norwegian bark Sidon, which had just arrived from Cardenas, had sailed, when in latitude 40° and longitude 71°, through large quantities of dead codfish, which lay floating upon the waters over a distance of 50 miles of the vessel's course. The bark is now lying at Gray's wharf, at the North End, where she will discharge her cargo of sugar. In a visit to her berth yesterday afternoon the writer found the captain to be absent, but the mate and one of the crew who were on board, verified substantially the fish story, though they toned it down considerably in respect to the distance sailed, which the seaman, who said he saw the fish, thought might be 10 or 12 miles. It was the mate's watch below at the time, and he could say nothing from ocular knowledge, though he did not doubt the testimony of all who were on deck at the time. The floating fish were of large size, and were visible on both sides of the ship as far as the eye could reach. An attempt was made to catch one of them with a boathook, but the vessel was sailing so fast that it proved impossible to do so. The mariners have no theory to account for this fish fatality, but say they never saw or heard of the like before. The fact—for there is no reason to doubt the story of the seamen—has certainly an interest beyond that of a mere momentary wonder, for it may serve to explain the unwonted scarcity of fish complained of in some seasons. It has been the fashion to accuse the 'trawlers' of being the guilty cause of these disappearances of fish, and it has been declared that the codfish will soon become as extinct as the dodo unless this practice of trawling were given up, and the old honest way returned to of fishing with a single line and taking out from the sea one fish at a time. More recently lament was made about the invention of a new sort of 'exterminator,' in shape something like a drag-net, which is hauled along the bottom of the fishing vessel under sail, and scoops in thousands of fish in a few hours. However ruinous these practices, it would seem that they are quite eclipsed by the mode of destruction, whatever it may be, of which the mariners of the Sidon saw proof."

The following letter to Prof. Spencer F. Baird from Mr. Joseph O. Proctor, one of the leading citizens of Gloucester, Mass., inclosing the

foregoing newspaper paragraph, shows what an interest was felt in the sea-coast towns of New England concerning this event, and demonstrates most forcibly how the welfare of large communities engaged in the fisheries might be affected were such a mortality to occur among the species of fish most commonly sought for food:

"DEAR SIR: The inclosed paragraph was clipped from the Boston Advertiser of to-day. I have heard nothing more about it than what I read in this article. I call your attention to the matter with the thought that you would cause such an investigation to be made as would give you all the information obtainable. All kinds of ground fish have been very scarce on this shore all the winter season, and our vessels that fish on George's, Brown's, or Le Have Banks, have not found what they call a school of fish for many months.

"GLOUCESTER, MASS., *March* 21, 1882."

As the bark Sidon was one of the first to report the presence of the dead fish at sea, the following letter to Prof. Baird, from the secretary of the Boston Fish Bureau, Mr. W. A. Wilcox, containing many additional details, is of special interest:

"DEAR SIR: I have just seen the master of the bark Sidon, from Cardenas, West Indies, to Boston. The captain, Ole Jorgensen, reports as follows:

"Tuesday, March 14, in lat. 40°, long 71°, from 1 p. m. until dark they sailed through large numbers of dead fish floating on the water. The weather was cold and stormy, with strong northwest wind. The vessel was sailing from 6 to 8 knots an hour, equal to 40 or 50 miles, in which they passed through the fish. They attempted to catch some of them, but did not succeed. He judged the fish were from 1 to 4 feet long—mostly from 1 to 2 feet. They could be seen in all directions as far as the eye could reach, but only *scattering*, sometimes as many as twenty being seen at a time near the vessel. The captain could form no estimate of the numbers seen, and could only say it was *many thousands*. As the sea was quite rough they could be seen only as they came up on the crest of the waves. The next day, March 15, they had a gale, accompanied by a snow-storm, and no fish were seen, although they may have passed through them.

"The bark Henry Warner is reported to have passed through the fish in lat. 37°, long. 71°. I regret I could not see the master. The vessel is now at Portland, Me., and I presume a letter will reach him there.

"If you can give me a description and some account of the Tile-fish I shall be very much obliged. Our papers would like it and be pleased to publish it, with your request for any information in regard to those seen floating on the sea. Are they not the species taken by the Fish

Hawk in 1880, and that you sent a sailing vessel after in 1881, the vessel securing a few and ran home from a threatening storm?

"Any information you can give me will be thankfully received, and if I can find out any more of interest I will let you know at once.

"BOSTON, *March* 28, 1882."

Four days before the crew of the Sidon had seen the dead fish the brig Rachel Coney, Capt. Lawrence Coney, of Bangor, Me., had passed over nearly the same track.

I am indebted to Mr. A. R. Crittenden, of Middletown, Conn., for valuable information relating to this event, which he obtained during a personal interview with Captain Coney.

The Rachel Coney sailed through the dead fish on the 10th of March, a distance of about 40 miles on a north-northeast course. "They were first noticed," says Captain Coney, "about 75 miles south-southwest from the light-ship on the South Shoal of Nantucket, and we continued to see them for seven hours, the brig running along about 6 knots."

Captain Coney makes special mention that the largest of the fishes seen, which were from 2 to 3 feet long, were remarkable for having many large bright spots on the back and dorsal fin, and also for "a curious fin on the back of the head or nape," which he calls the "pilot fin." This description, supplemented by a rough drawing made by Captain Coney and forwarded to me by Mr. Crittenden, proves unquestionably that the largest of these floating fish were *Lopholatilus* and *not* cod, as reported by the Sidon. Another species of fish seen by Captain Coney, and which he has also roughly figured, was undoubtedly the *Peristedium miniatum*, of which fuller mention will be made in a succeeding paragraph.

About the same time that the bark Sidon arrived in Boston (possibly sooner) the bark Plymouth reached New York, and the captain of the latter vessel reported having sailed through dead fish for a distance of *sixty-nine miles*. The following paragraph from the New York Tribune gives the result of an interview with the captain of the Plymouth:

"At the office of State Fish Commissioner E. G. Blackford, it was reported yesterday by Captain Lawrence of the bark Plymouth, of Windsor, Nova Scotia, that he had seen a great quantity of dead codfish in the waters off the George's Bank. A Tribune reporter called on Captain Lawrence to learn the facts. The story as told by him was as follows: 'A week ago last Saturday we were sailing off the George's Bank. About daylight on Sunday morning the mate came down into the cabin and said that the bark was passing through a lot of dead codfish, and wanted to know if he should get some of them. I went out on deck and saw that the water all around us and for miles back of us was filled with these fish. Their gills were red, and upon scooping up some of them I found that they were hard, showing that they had not been dead very long. From 6 o'clock in the morning until 5 o'clock

in the evening we were passing through this school of codfish, and as we were sailing at the rate of 6 knots an hour we went through 69 miles of them.'

"'Did you eat them?' inquired the reporter.

"'No,' said Captain Lawrence; 'not 69 miles of 'em. We ate a few.'

"'And this is not 'a fish story?"

"'Hardly. Three other vessels report the same facts.'

"'Sixty-nine miles of dead fish are some fish,' suggested the incredulous reporter.

"'You're right,' said the captain, 'and that's the point of the story. They weren't all cod; there was a kind of fish looking like sea bass; and, also, a lot of red snappers. We also found some broken ships' 'knees.'

"'How do you account for this?' the reporter asked of Captain Mortimer, of the Black Ball Packet Line, who was standing in Mr. Blackford's office.

"'Well,' said Captain Mortimer, 'I don't know that I can. If they had died of disease they would have drifted off to the southward, for the current known as the polar current is now running very strong. It's not unlikely that the icebergs grounded off the Bank may have made the water so cold that they couldn't stand it. But cold water doesn't affect codfish, does it, Mr. Blackford?'

"'No,' said the fish commissioner, 'cold water wouldn't affect them, unless they were salt. I don't know what it was. I'm going to acquaint Professor Baird with the facts. It is a matter of interest to the Commissioners.'

"'When I first reported the facts here in the city,' said Captain Lawrence, 'I said there were 15 miles of them. I thought everybody would think it a 'fish story' if I said 69 miles.'"

As will be observed, the most of those who first saw the dead fish were of the opinion that they were all, or nearly all, cod, or, at least, that they belonged to that family. The accounts as to the kinds seen were so conflicting, and the popular names given to fish by seamen differ so widely, that only a conjecture could be formed as to the identity of the species to which this mortality had occurred. A writer in the New York Times of March 26, 1882, alluding to this subject, says:

"In the determination of the kind of fish just found at sea, the United States Commission met with a great deal of difficulty on account of the uncertainty of the descriptions given by captains and sailors. The vulgar nomenclature of fish is of the most extraordinary kind. A Jersey fisherman will call the most ordinary fish by a local name, while if the same fish were caught by a Delaware or a Boston fisherman, the name being changed, the exact kind of fish meant would be quite unrecognizable. Some said these fish were shad, others bass; some declared them to be red snappers."

Professor Baird, however, from the first, suspected that the fish seen dead and floating in such immense numbers at sea were Tile-fish, and he immediately instructed his correspondents in the principal seaports to collect all possible information bearing on the subject. The following letter was sent to Mr. Eugene G. Blackford, New York State fish commissioner, a gentleman well and favorably known for the interest he has always shown in matters connected with the scientific study of American fishes:

"MY DEAR MR. BLACKFORD: I wish very much you would gather up all the information you can in regard to the occurrence of the dead fish, and also any indications observed which may lead to a definite conclusion as to what kind of fish they were. So far as I can judge from Boston and New York papers, they, in part, at least, were Tile-fish. It is possible, their appearance being almost concurrent with, or but slightly subsequent to, the great storm off George's Bank, that the commotion of the waters may have killed the fish by concussion and started them shoreward. It is a thousand pities that fishermen and others have not sufficient intelligence or curiosity on such occasions to bring specimens home and have them carefully examined. The fact that there was no evidence of disease, but, on the contrary, the fish were palatable and sound, would suggest that the cause of death was rather a mechanical one.*

"WASHINGTON, *March* 24, 1882."

At the same time, however, that the above letter was written to Mr. Blackford, a specimen of the dead fish was being forwarded to Washington from Philadelphia, accompanied by the following letter from James W. Rich to Professor Baird:

"DEAR SIR: I send you by express to-day a sample of the fish picked up off Nantucket, about 70 miles southwest. They appear to be different from any fish I have yet seen, and I cannot find any old fishermen that have seen anything just like them. We sailed through some 60 or 70 miles of them, and they appeared to be rising to the top of the water all the time. Their eyes and blood were as bright as could be when taken on board. I see several vessels have passed through them as codfish, but they are different from the ordinary codfish. I shall be pleased to hear from you when convenient, as I would like to know what the fish are and where they come from.

"PHILADELPHIA, *March* 24, 1882."

The receipt of this specimen, which proved to be a Tile-fish, solved the problem in regard to the species to which the chief part of the dead fish belonged. Referring to this, the New York Times remarks: "It

* This letter appeared in several of the leading New York dailies and also in other newspapers.

will be seen from this letter,* as Professor Baird believed, that the fish was the *Lopholatilus*, or Tile-fish—how shrewd a guess he made."

On receiving the letter from Captain Rich, Professor Baird sent him a telegram and also wrote to him to obtain further details, which the former supplied in the following replies:

"DEAR SIR: Your telegram is at hand, and I am sorry to say I had all the fish cleaned and put on ice. I expect to sail for Boston early next week, and if I come across any more of them will try to get some and ship to you whole. I could discover no appearance of disease about the inwards of any of them; the eyes, gills, blood, and liver were as bright as when living. The liver would not float, and had very little, if any, oil in it. What the fishermen call the 'poke,' or pouch (of a hake), was hanging out of the mouths of about one-half of them, and there was no food of any kind except in one, a small dogfish. I did not try the temperature of the water, but the air was very cold and made heavy ice on deck that night.

"PHILADELPHIA, *March* 25, 1882."

"DEAR SIR: Yours of the 23d is at hand and noted. We first noticed the dead fish about daylight on the morning of March 15, in latitude 40°, and sailed through them on a west by south course from longitude 70° to 71°. When first seen there were a few redfish with them, but when we lowered the boat there was nothing but the Tile-fish in sight; none of them were alive, but none of them swollen, but they appeared to be coming up all the time. Sometimes there would be only two or three in sight, and at others thirty or forty of them. I have seen fish in the winter at the mouth of rivers in South Carolina that would rise to the surface dead yet bright as these fish were, apparently chilled from striking the cold water, and my theory is that the Tile-fish were killed by the cold water, as I found nothing that appeared to be diseased about them.

"PHILADELPHIA, *March* 27, 1882."

Other vessels arriving at this time reported having seen the masses of floating fish, and a few succeeded in obtaining specimens, which were eaten. But, strange to say, with the exception of the one brought in by Captain Rich, none were saved for identification by the captains of the incoming vessels. A writer in the New York Times of March 26, 1882, gives the following account of an interview with the captain of the bark Elizabeth Ostle, one of the few vessels which secured specimens of the *Lopholatilus*:

"Going on board of the bark Elizabeth Ostle, Capt. O. Lamb, just from Calcutta, now moored in Brooklyn, near the Wall-street ferry, the

* The letter written by Professor Baird to Mr. Blackford March 24, 1882, quoted above.

commanding officer having reported the presence of such fish, a series of interrogatories were presented to him by one of the members of the American Fish-cultural Association, who was accompanied by Capt. John Mortimer. Captain Lamb said that on the 21st of March, when about 65 miles off-shore from Barnegat, he sailed for 40 miles at least through waters filled with these dead fish. Having been asked if he could describe the number of fish in a given area, taking his ship's cabin as indicating the space, Captain Lamb replied that 'there would be fully 50 dead fish within that space. The sea was quiet and we were going about from 4 to 5 knots an hour, and we sailed for some seven to eight hours, say 40 miles, with these dead fish alongside of us. There were millions of them. From my log I find that the exact locality was 39° 7′ north latitude, and the longitude 73° 10′ west. We had been sailing all the morning north by west, and were well inside of the Gulf Stream. The temperature was 45°. We found these fish when we could not get soundings.' Captain Lamb had not eaten any of the fish, but calling in the carpenter, who had partaken of the fish, having caught two of them, the man was questioned. 'The fish was a curious fish,' the carpenter said. 'He had never seen the like before. There was in the crew a Nova Scotia man, and he did not know what kind of a fish it was. I took two, and they were fresh and sound. The gills were red, and they bled when opened. The head was curious—different from what I had ever seen on a fish before. One thing I took notice of was a certain lot of yellow spots on the sides of the fish. They would weigh about from 8 to 9 pounds.'"

A single individual only of the dead fish was secured by the bark Alf which arrived in New York March 24, 1882, but her captain was very positive that he saw several species of dead fish besides the Tile-fish. The following account of an interview with him is taken from the New York Herald of March 28, 1882:

"I am Captain Larsen, of the Norwegian bark Alf. I arrived in New York on March 24. On Wednesday last, when just inside the Gulf Stream, about 70 miles south-southeast off Sandy Hook, I saw for 60 miles scattered over the water thousands of dead and dying fishes. This was in about 15 fathoms of water. I noticed four different varieties. I do not know the names of any. I picked up one but did not eat it. (From the captain's description it was evidently a Tile-fish.) The majority of the fishes floating about were similar to it, but dispersed among them there were queer looking fishes, all red on top, that had two protruding horns. These were smaller in size than the fish I secured, which was 2½ feet in length. Besides these there were large, flat, brown-looking fishes, and thousands of small fishes, shiny in color, about a foot long."

In the same paper is given another captain's statement.

Captain Porter, of the bark Avonmore, said: "I have just arrived in port. On March 25, when in north latitude 39° 15′ and about 100 miles

off land in a southeasterly direction from Barnegat Light, we passed for four hours, sailing under a 5-knot breeze, through thousands of dead fishes which were floating on the water, which was quite calm. The fish were grouped together in lots of a dozen or more, while others were scattered singly. During all this time they were never out of sight. I did not try to pick any of them up. They looked like catfish, and were about a foot and a half long. Since my arrival a number of captains have spoken to me about seeing the dead fishes; but from what I can gather I believe there were a far greater number of fish to the northward than on the course I was sailing."

These reports were supplemented a few days later by the following letter to Professor Baird from the secretary of the Boston Fish Bureau, who was indefatigable in securing information relative to this subject:

"DEAR SIR: I fear you may be tired of hearing of the 'dead fish,' but I will venture to give you the report of Capt. I. B. Foss, of schooner Navarino, from Mobile to Boston:

"He first noticed large numbers of dead fish floating in the sea Tuesday, March 21. At that time in latitude 30° to 40° N. longitude about 72° 30′ W. Passed through the fish on that day and night, and also the 22d all day, during which time they must have sailed at least 150 miles. The fish were scattered over the seas as far as could be seen; at times quite thick; hundreds near the vessel. While most of the fish were strange to captain and crew, they were quite sure a small portion of the largest were *cod* and *hake*. The fish appeared to be from 1 to 4 feet long, mostly from 1 to 2 feet. Not any of the fish were secured. Weather at the time cold, with strong northwest wind.

"The master of schooner Lena R. Storey I have not seen, but am told that he reports the same as above, only he was three days behind the Navarino. He also says that he knows some of the largest fish were cod.

"In my previous report of brig Sidon, the master reported the date March 14. I think he was mistaken just one week, as all other reports were the 21st. I regret that he had sailed ere I could see him to correct the date if in error.*

"Thanks for yours of the 31st. I shall be pleased to receive the cut of the Tile-fish, and anything that you can give as to the cause of the destruction will be of interest. The general opinion expressed here is that the fish were killed by some volcanic or other great convulsion of nature. Much interest is taken in the matter.

"Gloucester firms are contemplating sending a vessel out after Tile-fish if they are not all killed. * * *

"BOSTON, *April* 3, 1882."

* The date given, March 14, is without doubt the correct one. It could not have been the 21st, as Mr. Wilcox supposes, since on that date the account of the circumstance appeared in the Boston papers. Some of the vessels which arrived at New York reported seeing the dead fish several days earlier than the Sidon.

This, it was supposed, completed the history of this wonderful event, and the excitement and interest that had been created by this spectacle of thousands of square miles of the sea covered with dead fish it was scarcely expected would be revived. Mr. Barnet Phillips, of the New York Times, a gentleman much interested in all matters pertaining to the scientific study of the fishes, impressed with this idea, collected as full a list as he could of the vessels which had sailed through the floating fish and sent it to Professor Baird.

Below is the list and other data sent by Mr. Phillips:

Bark Plymouth, arrived in New York March 15, 1882, found fish off George's, March 3.

Bark Montreal, arrived in New York March 13, 1882, found fish off George's.

Steamship Beila, arrived in New York March 21, 1882, found fish 60 miles south of Barnegat on the 20th of March.

Ship British America, arrived in New York March 21, 1882, found fish 45 miles south of Shinnecock on March 20.

Bark Elizabeth Ostle, arrived in New York March 23, 1882, found fish in latitude 39° 7′ on March 21. (Reported in full in New York Times.)

Bark Sidon, arrived in Boston March 21, 1882, found fish in latitude 40°, longitude 71°, on the 14th of March.*

But, strange to say, about a month after the events related above, and just two weeks subsequent to the date of Mr. Phillips's letter, dead fish were found floating off the capes of Virginia, by some of the Gloucester mackerel schooners, and specimens of these were secured and brought into New York by the fishermen, many of whom have for several years shown much interest and enthusiasm in collecting material that they think may aid Professor Baird in his scientific research of American waters.

The New York Times of April 22, 1882, thus describes the arrival of these specimens in New York:

"Yesterday the New York State fish commissioner, Mr. E. G. Blackford, had on exhibition one of the largest of Tile-fish which has yet come to hand. It weighed, when gutted, 43 pounds, and was, when entire, a bigger fish than the one caught by Captain Kirby some few years ago. The fish, with its peculiar large head, its nuchal crest—that long adipose fin projecting from its nape—was of a violet tinge with marked yellow patches. This fish was taken by Captain McLain, of the schooner Herald of the Morning, on Thursday, in latitude 37° 29′ and longitude 74°, some 85 miles from the capes of Virginia. The fish was floating on the surface of the water, belly upward, and was taken by a gaff and

* As will be seen this list includes the names and other important data concerning three vessels which we have not been able to secure elsewhere, and its value is correspondingly great. It enables us to fix more accurately the area covered by the dead fish and also to determine with more definiteness than we otherwise could the limits of time during which this mortality prevailed.

brought on deck. Captain McLain stated that it was alive for three hours after capture. It was the only fish of this kind he had seen, and was a novel fish to him. The captain mentioned, however, that there were other kinds of fish in the water—dead ones—but that he had not thought it worth while to take any, but he said that Capt. W. Gibbs, of the schooner W. H. Oaks, he believed, had picked some up.

"With the New York State fish commissioner, who is always eager to see a new fish, was a representative of the New York Times, and they, after boarding several smacks, found the schooner Oaks, and Captain Gibbs, her skipper, produced the strange fish. Just as soon as this skipper hauled out one of those peculiar cans which the United States Fish Commission provides all captains of smacks with, in order that they shall preserve their specimens, it at once became evident that Captain Gibbs was an ichthyological enthusiast. The captain presented two very queer fish, which looked like a cross between a croaker (*Micropogon undulatus*) and a gurnard. But the difference was marked. The fish had spines, a long bony snout, and a hard, indurated case, so that they would be an exceedingly difficult fish to swallow. In size they were about 10 inches long. The alcohol had bleached them, and of their brilliant coloring there was nothing left but the tail, which was red. It is supposable that they belonged to a deep-sea fish. As it was, they were unknown to the visitors. Captain Gibbs said he saw hundreds of them; they were all dead, and of a brilliant red color. He had sailed for 3 or 4 miles through them. The latitude was 38° 5′, the longitude 73° 40′, and the nearest land, Winter Headquarters, 60 miles off, on the Delaware coast. There were no soundings. The weather was pleasant, nor had there been any blow for some days before. Captain Gibbs handed over his specimens to his visitors with a request that they should be sent to Washington to Professor Baird for examination.

"It seems probable that more specimens of the *Lopholatilus* have been taken on the same day—Thursday, the 20th—by other vessels than the Herald of the Morning, but a careful inquiry among the mackerel schooners at the docks failed to find any more Tile-fish. The Charles R. Lawrence, Captain Carter, may, perhaps, have come across some."*

The fishes brought in by the schooner William S. Oakes, were the *Peristedium miniatum*. This species was first known to science in the fall of 1880, when several specimens were taken in September by the

* The following letter from Mr. Barnet Phillips to Professor Baird, notifying him of the arrival of another specimen of the *Lopholatilus*, was received on the same day that the paragraph quoted above was published:

"I have just seen hanging at Blackford's a Tile-fish of 43 pounds. It was caugh yesterday—Thursday, 20th—by Captain McLain, in latitude 37° 29′, longitude 74°. Name of vessel, schooner Herald of the Morning. Distance from the capes of Virginia, 85 miles where fish was caught. When taken with a gaff it was floating, belly up, and when put on deck lived about two hours.

"I will try and find further particulars as to number of fish seen, &c.

"NEW YORK, *Friday, April* 21, 1882."

United States Fish Commission steamer Fish Hawk while dredging on the slope inside of the Gulf Stream. It was described by Prof. G. Brown Goode, in Vol. 3, Proceedings United States National Museum, 1880.

In 1881, the species was obtained on six different occasions, being taken on muddy or sandy bottom, in depths varying from 69 to 156 fathoms, and in an area between 39° to 40° N. latitude, and 70° to 73° W. longitude. None of these fish have been found elsewhere until picked up dead or in a torpid condition, as believed by some, by the mackerel fishermen off the coast of Delaware and New Jersey.

It is a fact worthy of notice that even as late as the 1st of May many of these fish, remarkable for their brilliant red color, were seen drifting about, and such individuals as were secured were found to be in a perfectly healthy and sound condition.

Capt. Amos Radcliff, of schooner Charles C. Warren, of Gloucester, while engaged in mackerel fishing on the 1st of May, some 30 to 50 miles southeast from Cape May, saw a great number of the *Peristedium* floating upon the surface. He secured several of the fish in a dip net, two of which he preserved in salt. One of these was presented to the United States Fish Commission.

Captain Radcliff says that at the time he saw these fish his vessel was lying to, but from subsequent observations he judged they covered an area of at least 5 miles in diameter. Over all this space they were exceedingly numerous, and a great many of them could be seen all the time the vessel was passing over that distance.

How much longer these fish continued to "turn up" it is difficult to say. As late, however, as the second week in July the writer saw a specimen which had been sent by Capt. I. F. Macomber, of schooner Alice Tarlton, to the editor of the Cape Ann Advertiser, in Gloucester, for identification. The letter that accompanied this fish, and which was published in the Advertiser of July 14, 1882, is quoted in another paragraph where it more properly belongs. No mention is made in it of where the fish was obtained, but presumably it was found floating near or at the same place where Captain Radcliff saw them so plenty, and probably at about the same time.

11.—AREA COVERED BY THE DEAD FISH.

The lack of precision observable in nearly all of the published reports concerning the points where the dead fish were first noticed, and where they were last seen by the several vessels which passed through them, renders the task of determining the area which they covered a somewhat difficult one. In most cases, however, this is not at once apparent, since the localities *seem* to have been carefully given. But a few words of explanation will illustrate this point. We will take, for example, the report of Captain Lamb, of the bark Elizabeth Ostle, which has already been quoted. He says that "on the 21st of March, when about 65

miles off-shore from Barnegat, he sailed for 40 miles through waters filled with these dead fish." * * *

"From my log I find that the exact locality was 39° 07′ N. latitude, and the longitude 73° 10′ W. We had been sailing all the morning north by west, and were well inside of the Gulf Stream."

This may *appear* to be definite, but is exactly the reverse. The question is, what part of his track through the dead fish was the position so exactly given above to mark? Was this observation taken, and the locality noted, when the fish were first seen, when the ship was half way through them, or as she neared their northern boundary and was about to leave them behind her? Of course, it is now impossible to get satisfactory replies to the above questions, and all, therefore, that can be done is to work out the problem as correctly as possible from the data at hand. Captain Lamb throws some light on the subject by saying: "We found these fish when we could not get soundings." As there is a depth of only 35 fathoms at the point where the position he gave (latitude 39° 07′ N., longitude 73° 10′ W.) would place the ship, it seems entirely probable that she was nearing the northern edge of the belt of dead fish when this observation of the vessel's position was made. I have, therefore, laid out the ship's track in accordance with this belief. In considering these questions, however, and in forming conclusions in regard to the tracks made by the different vessels through the floating *Lopholatilus*, I have been enabled, I think, to arrive more nearly at correct conclusions, because of the many reports which have been studied. Thus, the error of one report may be corrected by another, and *vice versa*, until a result is reached which can vary little from absolute exactness.

In consideration of the above I have felt compelled, though reluctantly, to depend to some extent on my own judgment in laying out the various tracks pursued by the different vessels and in estimating the area covered by the dead fish.

The conclusions arrived at have, however, been reached only after mature deliberation and a careful consideration of all the data bearing on this subject, and, though these may appear more or less arbitrary, I trust the explanations given will be sufficient to show that there are good reasons therefor. Following are the names of the vessels that reported the presence of dead fish—at least, those of which we have sufficient information to determine their positions—and a discussion of the probabilities of their sailing on the tracks through the Tile-fish that I have marked on the accompanying plate.

Taken in their chronological order we come first to the bark Plymouth, which sailed through dead fish on March 3, 1882, a distance of 69 miles, from latitude 40° 01′ N. and longitude 69° 51′ W., to latitude 40° 08′ N. and longitude 71° 27′ W., by estimation.

The published account gives no position other than that "we were sailing off the George's Bank." * * * "From 6 o'clock in the

morning until 5 o'clock in the evening we were passing through this school of cod-fish, and as we were sailing at the rate of 6 miles an hour we went through 69 miles of them."

The usual track of sea-going vessels bound from the eastward to New York, and going outside of George's, is about on the parallel of 40° north latitude, and as this is the latitude where Tile-fish have been found most numerous, it is more than probable that the track of the Plymouth was the one indicated on the map. The term "off the George's Bank," as used by sea-faring men, is very indefinite, being commonly employed in the most general sense. It is therefore presumable that the eastern limit of the dead fish seen by the Plymouth's crew was very near that which is given.

On the 10th of March the Rachel Coney, as stated elsewhere, sailed through the floating *Lopholatilus*, a distance of 40 miles while running for the South Shoal light-ship. Her position is given so definitely that it is unnecessary to discuss it.

Four days later (on March 14), the bark Sidon, bound in through the South Channel,* fell in with these dead fish. The account says: "In latitude 40°, longitude 71°, from 1 p. m. until dark they sailed through large numbers of dead fish floating on the water. The weather was cold and stormy, with strong northwest wind."

It is easy enough to decide on the course steered (though no mention is made of this), since the vessel would undoubtedly be heading nearly for the South Shoal light-ship, close-hauled, on the port tack. The difficulty is to decide just how long she sailed through these fish before reaching the position given above. Only one locality being mentioned, it seems probable that this was noted late in the afternoon. If we allow this it will be seen that the vessel's track, for "40 or 50 miles in which she passed through the fish," would be along the edge of the ground where Tile-fish have been caught, and where they were seen by other vessels; indeed, its northern end crosses the track of the Plymouth, while its entire length is nearly parallel with the northeastern end of the route through the dead fish made by the Navarino eight days later.

The next day (March 15) after the floating fish were seen by the crew of the Sidon, Captain Rich sailed through them a distance of 50 miles, on a west by south course, from latitude 40° N. and longitude 70° W., to latitude 39° 43′ N. and longitude 71° W. He gives his positions with exactness—the only one to do so—and this is of very great assistance in determining the routes sailed over by other vessels passing near the same locality.

* The broad channel between Nantucket Shoals and those on George's Bank is called the "South Channel." Vessels coming from the south, especially from the West Indies, as this one was, and bound to ports in Northern New England, usually pass through this channel, and, if practicable, shape their course so as to pass outside, but within sight of, the light-ship on the South Shoal of Nantucket.

But it was in the period from March 20 to 25 that the dead fish seem to have covered the largest area, and during this time the reports of their having been seen were more frequent than before or afterwards.

The ship British America is reported to have seen the dead fish on March 20, 45 miles south of Shinnecock, Long Island, which would place her in latitude 40° 05′ N., longitude 72° 24′ W. No mention is made of this ship having sailed through the dead fish for any distance, or, indeed, is any information given other than that the fish were seen in the locality named. The correctness of this even is open to a doubt, for it seems extremely probable that the dead fish were not so far north, since the position given is some 25 to 30 miles, at least, inside of where the Tile-fish might have been expected to occur. It is possible, however, that some unknown circumstance may have caused them to venture into waters of less depth than they had previously been found in, or they may have been carried by the wind and waves a long distance from the place where they first came to the surface.

On the same day (March 20) the steamship Beila reported seeing dead fish 60 miles south of Barnegat, which would be in latitude 38° 46′ N., longitude 73° 56′ W. The same may be said of the Beila as of the ship British America. The position given is far inside of where the fish were seen by other vessels, and in shallow water. Nothing is said of her passing through the dead fish for any distance, though she probably did, and in the absence of other data we can only submit such as are available.

March 21 the bark Elizabeth Ostle sailed through the dead fish from latitude 38° 37′ N., longitude 72° 58′ W., to latitude 39° 15′ N., and longitude 73° 15′ W.

On the same day the schooner Navarino, bound north, struck the dead fish in latitude 38° 41′ N., longitude 73° 01′ W., near the same point where they were first seen by the crew of the Elizabeth Ostle.* Running on a northeasterly course along the edge of soundings inside of the Gulf Stream, *the Navarino plowed her way through the dead fish from the 21st until night of the 22d, a distance of* 150 *miles, to latitude* 40° 17′ *N. and longitude* 70° 30′ *W., crossing the tracks of the Elizabeth Ostle, Alf, Avonmore, and Plymouth, and for* 40 *or* 50 *miles toward the northern end of her track, sailing nearly parallel with the course which the Sidon made through the Lopholatilus eight days before.*

On March 22 the bark Alf sailed through the dead fish from latitude 38° 37′ N., longitude 72° 54′ W. to latitude 39° 32′ N., and longitude 72° 26′ W., a distance of 60 miles. The account of the course sailed by the Alf is so indefinite that we can only guess at it. Captain Larsen says: "When just inside the Gulf stream, about 70 miles south-

* These vessels were sailing nearly at right angles to each other, and though the data are indefinite and unsatisfactory, they are, nevertheless, sufficient to arrive pretty closely at the positions where the dead fish were first observed and where they were last seen.

southeast from Sandy Hook, I saw for 60 miles, scattered over the water, thousands of dead and dying fish. This was in about 15 fathoms of water." Like nearly all the other statements we have, there is only one position given, but from the context and from a consideration of other data, we are able to estimate the probable course he made. The wind permitting, the bark would, of course, be sailing direct for New York, whither she was bound; otherwise, she would be steering close-hauled on a wind on whichever tack she could lay nearest to her course. Mr. Wilcox writes that the Navarino reported having a strong northwest wind, and it must have been on March 22 that this wind prevailed, for on the 21st the bark Elizabeth Ostle, in or near the same place as the Navarino, was on that day steered north by west, a course which it would be impossible for her to make with a northwest wind. With the wind at northwest, blowing a strong breeze, the Alf would, in all probability, be close-hauled on the port tack, heading along about N.NE., and, allowing for leeway, would be making a course about NE. by N.$\frac{1}{2}$ N. Admitting this—and there seems no reason to question it—the next thing is to determine where the fish were first seen. Captain Larsen says, "just inside the Gulf Stream, about 70 miles S.SE. *from* Sandy Hook." Now, as the position, "70 miles S.SE. *off* Sandy Hook," *is not just inside the Gulf Stream*, but about 115 miles from it, or nearly two-thirds the distance from it to New York, and as the captain of the Elizabeth Ostle found the dead fish on the previous day off soundings, though he called his position 65 miles from land—an evident error—we are compelled to believe that the Alf met with the dead fish near the same place where they were first seen by the crews of the Elizabeth Ostle and Navarino. It is probable that the northwest wind had driven the body of floating Tile-fish slightly from the position they occupied on the 21st, and that the Alf fell in with them a little to the southeast of where they were first encountered by the Elizabeth Ostle. Crossing the track of the Navarino at an acute angle the Alf stood on, gradually drawing on to soundings, and probably ran out of the fish a few miles northwest of where their inner edge was observed by the captain of the Avonmore three days later, at which time they had, without doubt, been driven somewhat to the southeast by the prevailing northwest winds.

As to the Alf sailing for 60 miles in 15 fathoms of water, it is enough to say that it is simply out of the question, since, if this were so, she would have been standing along the New Jersey coast, in sight of the land, and if such had been the fact it would doubtless have been mentioned.

For the reasons given above, it is probable that the track of the Alf, as laid down on the plate, is nearly the correct one.

March 25, bark Avonmore passed through dead fish from lat. 39° 15½′ N., long. 72° 03′ W., to lat. 39° 28′ N., and long. 72° 23′ W.

April 20, a floating Tile-fish was seen and captured by Captain

McClain, of the schooner Herald of the Morning, in lat. 37° 29′ N., long. 74° 00′ W.

About the same time dead fish were seen floating at the surface by the crew of schooner William S. Oakes, 40 miles in a northeasterly direction from where the specimen was obtained by the Herald of the Morning, and several individuals, as has been mentioned, were picked up in lat. 38° 05′ N., long. 73° 40′ W.

About the 1st of May dead fish of the species *Peristedium* were seen off Cape May, about from 15 to 30 miles southeast from Five Fathom Bank Light-Ship, by the crew of the fishing schooner C. C. Warren.*

Throwing aside for the present the consideration of the reports of those vessels which saw the dead fish in April, or later, we will proceed to consider the area which was covered in March, estimating this from such data as has been discussed.

The approximate length of 150 miles we get from the distance sailed by the Navarino, but if we consider the report of the Beila, this must be increased at least 20 miles, making a total length of 170 miles. The average width can be no less than 25 miles, and multiplying these together we find that the enormous expanse of 4,250 geographical square miles, or 5,620 square statute miles, was covered with a mass of dead and dying fish. If to this is added the area farther south, which was probably covered more or less thickly by floating *Lopholatilus*, a short time later (if not at the same time), as indicated by the specimens and reports brought in by the fishing schooners, we find that our estimate must be increased nearly a half more and would reach the sum of about 7,500 square statute miles.

In making these estimates I have thought best to keep them down to the minimum, so as to be within rather than outside of the probabilities, and have therefore not considered the reports of the ships British America and Beila in connection with the width of the estimated area. Neither do I think it desirable to take into account the possible area covered near the place where the fish were seen by the Herald of the Morning and the William S. Oakes. A bare allusion to the matter seems sufficient. In estimating the width of the sea area over which the Tile-fish were seen floating, I have thought best to make it about two-thirds as much as the several reports would indicate, thus allowing for any possible exaggeration—though all could not err in this particular—and the drift or spreading out of the fish after coming to the surface.

12.—PROBABLE NUMBERS OF DEAD FISH.

The question which is most naturally suggested to the mind when considering the immense area over which the Tile-fish were found is,

* The statements I have been able to obtain as to the exact locality in which these fish were seen by the crew of the C. C. Warren are not sufficiently definite to warrant me in giving the position in any other than a general way.

how many of these dead or helpless fish were there floating upon the ocean's surface?

We are aided somewhat in making the estimate by the reports of the several captains. Captain Jorgensen says they were "only *scattering*, sometimes as many as twenty being seen at a time near the vessel." Captain Lawrence remarks: "All around us, and for miles back of us, was filled with these fish." Captain Rich is more explicit. He writes: "Sometimes there would be only two or three in sight, and at others thirty or forty of them." Captain Lamb saw them more abundant than any one else, and estimates that in a space as large as his cabin there would be fifty fish. As the cabin would in all probability not be, at the most, more than 18 feet long by 15 wide, or about a square rod in area, this gives us a fair basis for making an estimate, but it seems that we ought to base our calculations on a much smaller number than was seen by Captain Lamb. That the fish were exceedingly abundant and literally covered the seas over a large part of the area where they were seen is altogether probable. Mr. A. R. Crittenden, who has had unusual opportunities for conversing with the captains who saw these dead fish, tells me that they all say that, while in some places the fish were comparatively scattering, for the most part they were so thick on the water that the vessels, as they sailed along, turned from either side of their bows "windrows of floating *Lopholatilus*."

Taking as a starting point the estimate of Captain Lamb, and calculating that the fish averaged in abundance one-twentieth what he reported their numbers to be, we find that there would be 256,000 in a square mile, and the astounding total of 1,438,720,000 fish drifting about on this part of the ocean in a dead or benumbed condition. Now, placing the average of these fish at 10 pounds, which is a little less than the average weight of Tile-fish, we get 14,387,200,000 pounds, or about 288 pounds of fish to each of the 50,000,000 of inhabitants of the United States. The enormous magnitude of these figures, and the extreme abundance of animal life on the unexplored grounds lying inside of the Gulf Stream, can only be comprehended, when we consider that if we reduce this still further, even dividing it by 200, and thus practically allowing that only one fish was seen where Captain Lamb said there were *four thousand*, we still find that the mass would rival in weight the product of some of our most important and valuable food fisheries. Taking all the concurrent testimony, however, it seems hardly necessary to make so low an estimate, and it appears reasonable that to place it at one four-hundreth of that of Captain Lamb, is, perhaps, putting it quite low enough. This would give the sum of 719,360,000 pounds of dead fish, and if we were to calculate on the same basis the probable numbers which were floating south of the area that has been considered, that is, down to the point where the Herald of the Morning was, this amount must be increased nearly one-half, or to about 1,000,000,000 pounds, in round numbers.

13.—SPECIES OF DEAD FISH OTHER THAN THE LOPHOLATILUS.

That there were more or less dead fish of species other than the *Lopholatilus* is unquestionable, though, from all the data we have at hand, it is evident that the greater part of these millions of floating fish were of one kind, and that of the species which forms the subject of this paper. Nearly all of the observers agree in saying that there were several kinds of fish, and especial mention is made of one having a brilliant red color, considerable numbers of which were seen scattered about among the larger forms. Fortunately, specimens of this red fish were obtained, and it has been definitely settled that they belong to the species *Peristedium miniatum*. Just what proportion of the floating masses this species represented can only be conjectured, but as it is a small fish and has been generally spoken of as if it was seen only occasionally or scatteringly, it seems probable that it formed only a small percentage of the great mass. Many of the captains thought that the fish they saw were cod, and the captain and crew of the Navarino, writes Mr. Wilcox, "were quite sure a small portion of the largest were *cod* and *hake*."

The following clipping, evidently from the Boston Herald, date not given, was sent to Professor Baird by Capt. S. J. Martin, and contains essentially the same facts as those quoted from Mr. Wilcox: "The schooners Navarino and L. R. Story report sailing through large quantities of dead fish for a distance of about 150 miles, first striking them in north lat. 38° 40″ and about 72½° west long. Captain Foss, of the L. R. Story, reports the fish to consist of fully *one-third part codfish and hake, the balance being of the new variety, christened by Professor Baird as Tile-fish.* Many of the codfish were very large, measuring from 4 to 5 feet in length."

This may have been so, but is open to a doubt; first, because the seamen employed exclusively in the merchant service have only the most general knowledge of the different kinds of fish, and are scarcely able to tell one from another, as may be observed by reading the accounts which have been quoted; second, Captain Rich, who I understand is a Cape Cod man by birth, and very possibly has been a fisherman at some period of his life, quickly detected the difference between the Tile-fish and the cod, and, writing to Professor Baird, he says: "I see several vessels have passed through them as codfish, but they are different from the ordinary codfish." Nor does he mention seeing the "ordinary codfish," though it is scarcely probable that so close an observer would forget to call attention to the fact if he had noticed any of the *Gadidæ*, all of which are so well known to any of the New England fishermen. That he would have done so is all the more probable, since he says, when writing of the Tile-fish "When first seen there were a few redfish [*Peristedium*] with them, but when we lowered the boat there was nothing but the Tile-fish in sight."

From the descriptions given the fish seen by the crews of the Elizabeth Ostle and the Avonmore were undoubtedly all Tile-fish; at least no others are mentioned, and it is probable that the "Nova Scotia man," spoken of as one of the crew of the Elizabeth Ostle, would have quickly noticed the presence of cod or any of the other species of the *Gadidæ*.

But Captain Larsen, after speaking particularly of the *Lopholatilus* and the *Peristedium* (for from his description these were the fish he saw with few exceptions), says: "Besides these there were large, flat, brown-looking fishes and thousands of small fishes, shiny in color, about a foot long." As to the species to which these last two mentioned kinds belong it is useless to conjecture, and we must therefore leave it as one of the unsolved problems of this most wonderful phenomenon.

14.—THEORIES ADVANCED AS TO THE CAUSE OF THE MORTALITY.

Were these millions of fish dead, or were they only in a torpid condition, with their vital functions temporarily suspended?* If dead, what was the cause of this wholesale, this astounding destruction? If not dead, but only benumbed, to what shall we ascribe the phenomenon? These are the questions which most naturally arise in the mind when studying the various phases of this singular appearance of millions of fish floating on the sea, and it is not at all strange that many and varied theories have been advanced to account for the strange occurrence. From the very nature of the case we cannot arrive at any definite conclusions as to the facts, and must therefore, for the present, at least, content ourselves with conjecture. Nothing further, therefore, will be attempted here than to present the several theories which have been advanced, and to discuss in as impartial a manner as possible the probability of their correctness.

The generally received opinion in regard to the floating fish was that they were dead, but this was not the belief of all, as is shown by the following letter published in the Cape Ann Advertiser of July 14, 1882, previously referred to, and with which was sent to the editors of that paper a specimen of the *Peristedium*, one of the "small fish" alluded to in the letter, and which I saw:

"*Messrs. Editors:*

"The large quantities of fish found floating last fall and winter between Cape Hatteras and New York were reported as dead. I fell in with many of both last fall† and this spring, and had the curiosity to examine them, and found that they were not dead, but apparently blind, having air bubbles inside of the outer covering of their eyes. On taking them

* In the account of the cruise of investigation in the smack Josie Reeves, which is appended to this paper, it will be seen that there is strong presumptive evidence that most if not all of the floating fish were dead, or finally died.

† The allusion made here to fish having been found the previous fall is an evident error, for no other statement to that effect has been received.

on board and laying them on deck in the warm sun, four out of five partially recovered and moved. Among those seen last year were hake, and I have heard of cod being seen. Some of the small fish had so much life that they would dart away a few feet on being disturbed. One of the number I secured, which I have preserved and forward to you. Please interest yourselves in finding out the name and class it belongs to and let me know. The color of the fish when taken was red.

"Yours, very truly,

"I. F. MACOMBER,
"*Schooner Alice Tarlton.*"*

Captain Coney, of the brig Rachel Coney, says that most of the floating fish he saw were not dead, but apparently benumbed or "loggy," as he expresses it. He thought their condition was owing, perhaps, to a lack of food, for he found nothing whatever in the stomachs of a dozen or more of the fish which he opened.

Captain McLain, of the schooner Herald of the Morning, says that the Tile-fish that he secured, and which was the only one he saw, was apparently alive when taken from the water, and retained its muscular activity in a most wonderful manner for quite three hours, so that, even after being eviscerated and placed on ice, the involuntary action of the muscles caused it to move to such an extent that it fell out of the pen onto the ice-house floor.

Other observers noticed that at least some of the fish had the appearance of being alive, though as previously stated, the general opinion seems to have been that the majority were dead. Undoubtedly this last-mentioned opinion was correct, and it seems highly probable that few indeed of these millions of floating fish ever regained sufficient strength to enable them to return to their usual haunts, even supposing they were not all dead when seen.

But whether the fish were dead or only temporarily disabled, their appearance upon the surface of the water in such extraordinary numbers is unquestionably due to some special cause, and probably only

*The mention of "air bubbles inside of the outer covering of their eyes" is a feature worthy of notice in this connection, since a similar appearance is often noticeable in some of the *Gadidæ*, especially the cusk (*Brosmius americanus*) when caught on a trawl. Though the fish are rarely dead when they come to the surface of the water, their eyes seem forced nearly out of their heads and are filled with air bubbles, while their stomachs are usually turned inside out and distended to their utmost extent with air. The fish are said to be "poke blown," and, though still retaining considerable activity and muscular motion, it is extremely doubtful if they are ever able to regain sufficient strength to enable them to return to their normal condition. I deem this all the more improbable, since I have often seen fish drifting about on the surface of the sea which had broken loose from a trawl, and which, notwithstanding repeated exertions and flappings of their tails were totally unable to recover themselves sufficiently to get underneath the water, or to prevent themselves from floating belly up. Undoubtedly, in nearly all such cases, the fish, if still "lively" when they first came up, have evidently died because of the unnatural position in which they were compelled to remain.

one. But we cannot positively determine whether this phenomenon was due to a sudden fall of temperature of the sea, a submarine volcanic action, a lack of food, or some other of the many possible causes assigned by different theorists. Therefore the best that can be done is to consider, in their various bearings, the several theories which have been advanced as the cause of this mortality.

The theory that perhaps was most generally advanced by those who studied the subject was that these fish (quite possibly at that time just approaching the coast) met with a stratum of unusually cold water, which paralyzed and rendered them helpless to such an extent that they floated to the surface of the sea dead or in a dying condition. The furious northerly gales which swept the region where the dead fish were seen, and many hundreds of miles farther north, about the last of February or first of March, may have caused, as was thought by some, an unprecedented low temperature in the sea water in that locality. No doubt the prevalence of these winds at the time mentioned may have had much influence in changing the temperature of that part of the ocean, but if there was any material and unprecedented difference in this respect, it seems more than probable that it was caused chiefly by the unusual accumulation of ice on the eastern fishing banks off the coast of Newfoundland and along the southern shores of Nova Scotia. Many of the Gloucester fishermen, who visit these localities year after year, agree in saying that never before have they seen such a large quantity of drift-ice on the coast of Nova Scotia; neither have they known of its being so far to the southwest. There can be no question as to the influence exerted by this vast body of ice on the surrounding sea, and it seems reasonable to suppose that the polar current, flowing to the southwest, inside of the Gulf Stream, may have carried this cold water to an unusual distance, accelerated, as it undoubtedly was, by the force of heavy northerly gales. The statement of Captain Lawrence, who seems to have been impressed with this idea, is corroborative of the above. He says: "The current known as the polar current is now [in March, 1883] running very strong. It's not unlikely that the icebergs grounded off the banks may have made the water so cold that they [the Tile-fish] couldn't stand it." Captain Rich, too, ascribes the death of the Tile-fish to excessive cold. It is a well-known fact that an extraordinary amount of cold will cause even the hardiest of fish to float dead and helpless upon the surface of the water in the same manner as the Tile-fish were seen. We know that even the codfish, a species which can endure the cold of the northern seas, when confined in the well of a smack and suddenly brought in contact with very cold water, will quickly die and float, belly up, at the surface. This is often observable in Fulton Market slip, New York, in winter, when the smacks, coming in from the fishing grounds with a load of live codfish, meet with floating ice in the harbor; at such times the fish will all be either dead or helpless in a few minutes.

I have been told by fishermen that they have seen large numbers of cod floating upon the surface of the water on the coast of Labrador, when several icebergs, drifting into a small bay, has caused a very decided and sudden fall in the temperature of the water. Such fish as were in the bay would soon become entirely helpless, and drift whichever way the winds or currents carried them, unless, indeed, as was often the case, many of them were picked up and carried on board of the vessels by the fishermen. Captain Kirby says that on one occasion, when he was at Cape Charles Harbor, on the coast of Labrador, about the 1st of August, 1876, he saw an immense number of codfish floating at the surface of the water, and spreading over an area of at least from 4 to 6 square miles. More than 300 quintals were picked up and cured by the local fishermen. At the time these fish were seen an unusual number of icebergs were grounded in the vicinity. As many as seven or eight large bergs were within an area of 4 or 5 miles, "while," says Captain Kirby, "we counted forty bergs one day while standing on the hills of Cape Charles."

The fishermen were of the opinion that the excessive coldness of the water, caused by the proximity of so much ice, had killed the fish, and no doubt they were right.

A similar phenomenon has been observed on the coast of Northern Europe, which also occurred to the *Gadidæ*. Though no special cause is assigned, it may be, and possibly was, due to some sudden change in temperature. In a letter addressed to Sir John Sinclair, cited by Milner in his Gallery of Nature, the statement occurs that on the 4th of December, 1789, the ship Brothers arrived at Leith from Archangel, and its captain reported "that on the coast of Lapland and Norway he sailed many leagues through immense quantities of dead haddocks," and "he spoke several English ships which reported the same fact." It is also stated by the writer that haddock, which was the fish in greatest abundance in the Edinburgh market, was scarcely seen for three years.

The following letter from Brigadier-General R. B. Marly, U. S. A., to Professor Baird is of very great interest in this connection, showing, as it does, how the destruction of great multitudes of fish, as well as other marine animals, may occur in the southern waters by reason of a sudden change of temperature, caused only by the prevalence of strong northerly winds, such as we have noticed as occurring about the time when the Tile-fish were seen.

"MY DEAR PROFESSOR: On reading a brief account of the fish that were recently seen floating upon the surface of the ocean near the Gulf Stream in a torpid or dead condition, and which I have not seen accounted for, it occurred to me that I could throw some light upon the subject, which the following facts within my own observation will show:

"You will remember that our troops under General Taylor passed the winter of 1845–'46 at Corpus Christi, Tex., and while there we one

night were visited with a pretty heavy frost, which seldom ever occurred in that locality, and, much to our astonishment, the beach in the vicinity of our camp on the following morning was thickly strewn with fish and green turtles that had floated up from the gulf. The fish were perfectly torpid, and the turtles, upon their backs, perfectly paralyzed, so that we picked up many wagon-loads, sufficient to feed the entire army.

"It is a well-known fact that neither men nor animals can endure any great degree of cold in that latitude and climate, for it is not uncommon for both to perish when exposed to the piercing 'northers' which sweep over those prairies, notwithstanding the thermometer rarely falls to the freezing point. I lost thirty-five mules out of a herd of one hundred and ten in one of these rain-storms during a single night. They laid down and died while they were in good flesh.

"The fact is that all animal life seems unable to endure any great change of temperature in that climate, and I therefore am of opinion that the fish observed floating upon the surface near the Gulf Stream perished from encountering the sudden change of temperature in passing from the warm water to the unusually severe cold water outside the stream.

"Moreover, those fish may have been carried by the current from the Gulf of Mexico to the much higher northern locality where they were observed.

"It appears by one statement that several varieties of fish were seen, but if only one kind was noticed that particular kind may have been more sensitive to the change of temperature than others.

"Your statements that the fish were perfectly fresh and free from apparent disease, with merely the vital function suspended, would go to corroborate my views, as our fish at Corpus Christi were in a similar state.

"NEW YORK HOTEL,
"*Washington, April* 2, 1882."

Since the foregoing was written the following interesting paper relative to this subject from the pen of Prof. A. E. Verrill, of Yale College, has been published in the New York Times of October 29, 1882. Professor Verrill, having been connected with all the researches made in this locality by the United States Fish Commission, under the direction of Professor Baird, is unquestionably one of the best authorities that can be cited, and I take pleasure in quoting extensively from this article, since it throws light on many points which have not been considered in the preceding sections of this paper. He writes:

"In the autumn of 1880 the United States Fish Commission commenced the exploration of the sea bottom along the edge of the Gulf Stream, about 90 to 110 miles off the south coast of New England. The results then obtained were so interesting and important, and the discoveries of new forms of life were so unexpectedly numerous and

remarkable, that similar explorations were continued in 1881, and again during the past season. This year and last Prof. S. F. Baird, the United States Commissioner of Fish and Fisheries, established the headquarters of the Commission at Wood's Holl, Mass. This place will hereafter be made a permanent station of the Fish Commission. Owing to the unusual delay of the Government appropriations our work was delayed this year about a month in the best part of the season, for we could not begin dredging until August. Unfavorable weather and other causes afterward prevented us from making more than five trips to the Gulf Stream slope this season, but these were very successful.

"Our dredgings in this region now cover a belt about 160 miles long east and west and about 10 to 25 miles wide. The depths are mostly between 70 and 700 fathoms. The total number of successful hauls made along this belt is now about one hundred and twelve. These have nearly all been made with our large improved trawls; a few have been made with a large rake dredge. At all localities the temperature of the water, both at the bottom and surface, was taken, as well as that of the air. In many cases series of temperatures at various depths were also taken, and other physical observations made and recorded. Lists of the animals from each haul have been made with care and arranged in tables. In this region the bottom slopes very gradually from the shore to near the 100-fathom line, which is situated from 80 to 100 miles from the mainland. This broad, shallow belt forms, therefore, a nearly level plateau with a gentle slope seaward. Beyond the 100-fathom line the bottom descends rapidly to more than 1,200 fathoms into the great ocean basin, thus forming a rapidly sloping bank as steep as the side of a mountain and about as high as Mount Washington, New Hampshire. This we call the "Gulf Stream slope," because it determines practically the inner border of the Gulf Stream all along our coast from Cape Hatteras to Nova Scotia. In our explorations a change of locality of less than 10 miles would often make a difference of more than 3,500 feet in depth on this slope. The upper part of the slope and the outermost portion of the adjacent plateau, in 65 to 150 fathoms, is bathed by the waters of the Gulf Stream, and consequently the temperature of the bottom water along this portion is decidedly higher than it is along the shallower part of the plateau nearer the shore. Moreover, the Gulf Stream itself is limited in depth to about 150 fathoms or often less, and below this the temperature steadily decreases to the bottom of the ocean basin. We may therefore properly call the upper part of the slope in 65 to 150 fathoms the "warm belt." Our observations give the bottom temperature of this warm belt as usually between 48° and 50° Fahrenheit. On this belt we took numerous kinds of animals that were previously known only from the Gulf of Mexico or off Florida. Some of them belong to tribes that have always been considered as tropical, or subtropical, such as *Dolium*, *Marginella*, and *Avicula* among the shells. In fact this belt is occupied by a northern

continuation of the southern or West Indian Gulf Stream fauna. On the lower part of the slope, in 150 to 780 fathoms, we find numerous Arctic forms of life, corresponding to the lower temperature which, in 300 to 500 fathoms, is usually 40° to 41° Fahrenheit. On the inshore plateau, which is occupied by a branch of the cold Arctic current, we also find Arctic species of animals. Probably no other equally large part of the ocean basin in similar depths has been so fully examined as this region. * * *

"Probably the total number of species of animals already obtained by us is not less than 800. The number already identified or described and entered on our lists of the fauna of this belt is about 650. This number includes neither the Foraminifera nor the Entomostraca, which are numerous, and but few of the sponges. Of this list less than one-half were known on our coast before 1880, and a large number were entirely unknown to science. Of fishes there are perhaps 70 species. Of the whole number already determined about 265 are Mollusca, including 14 Cephalopoda; 85 are Crustacea, 60 are Echinodermata, 35 are Anthozoa, 65 are Annelida.

"Although the Tile-fish remained unknown, both to naturalists and fishermen, until three years ago, it has already become somewhat famous. One of these fish was sent to Messrs. Goode and Bean, of the United States Fish Commission, for examination. It proved to be a remarkable new species, belonging to a new genus, and they immediately named and described it. The fish is bright colored, and covered with round, golden-yellow specks. Large ones are over 3 feet long and may weigh 40 to 50 pounds. In 1880 and 1881 the Fish Commission endeavored to test the abundance and range of this fish and also its edible qualities. It was taken by our steamer on several occasions during these two years by means of a long trawl-line, at different localities, many miles apart, along the warm belt of the Gulf Stream slope in 100 to 130 fathoms. Therefore it is doubtless a southern species, and will hereafter probably be found off our southern coast, or even in the Gulf of Mexico, at suitable depths. On one occasion, in 1881, we took 80 of these fishes, weighing 500 pounds, at one haul. The fish, after a satisfactory trial by many competent judges, was proved to be a valuable food-fish.

"After a severe storm last winter many vessels reported seeing great quantities of dead fishes of a strange kind floating at the surface of the sea in the same region where the Tile-fish had been discovered. These dead fishes were perfectly fresh and wholesome, without any appearance of disease or violence. Many of them were eaten. Some were sent to Washington for identification, and they proved to be Tile-fish. The dead fishes were reported as occurring abundantly over a large area—perhaps 5,000 square miles or more. There must have been millions of pounds wasted. It became, therefore, a matter of great interest and importance for the Fish Commission to ascertain during the

past season whether the Tile-fish had been nearly or entirely exterminated in this region, and if so, to investigate the cause.

"One of the most peculiar facts connected with our dredgings along the warm belt this season was the scarcity or total absence of many of the species, especially of Crustacea, that were taken in the two previous seasons, in essentially the same localities and depths, in vast numbers—several thousands at a time—and in many localities. Among such species were some peculiar small spider-crabs, hermit-crabs, and shrimp (*Euprognatha*, *Catapagurus*, and *Pontophilus*); also, curious small lobster-like creatures (*Munida*). The latter was one of the most abundant of all the Crustacea last year, but was not seen at all this season, with the exception of a single example on the last trip; the others were taken only in small numbers. Two attempts were made to catch the "Tile-fish" (*Lopholatilus*) by means of a long trawl-line on essentially the same ground where eighty were caught in one trial last year. On the last occasion this year the trawl-line used was about 2 miles long, with over two thousand hooks. Both of these attempts resulted in a total failure.

"In order to test the question of the disappearance of the Tile-fish more fully Professor Baird employed in September, a fishing-vessel, the Josie Reeves, to go to the grounds and fish systematically for the Tile-fish by using long trawl-lines, such as had proved successful last year in our trials. On her first trip, ending September 25, she fished three days in several localities at the proper depths and on the right kind of bottom, but did not catch a single Tile-fish.

"It is probable, therefore, that the finding of vast numbers of dead Tile-fish floating at the surface in this region last winter was connected with a wholesale destruction of the life at the bottom, along the shallower part of this belt, (in 70 to 150 fathoms,) where the southern forms of life and higher temperatures (47° to 52°) are found. This great destruction of life was probably caused by a very severe storm that occurred in the region at that time, which, by agitating the bottom water, forced outward the very cold water that, even in summer, occupies the wide area of shallower sea, in less than 60 fathoms, along the coast, and thus caused a sudden lowering of the temperature along this narrow warm zone, where the Tile-fish and the Crustacea referred to were formerly found.

"The warm belt is here narrow, even in summer, and is not only bordered on its inner edge, but is also underlaid in deeper water by much colder water. In fact, the bottom water further inshore is probably below 32° Fahrenheit in winter where the depth is 20 to 40 fathoms. In August, this year, we found the temperature 37° Fahrenheit, south of Cape Cod, in 55 to 60 fathoms. It is evident, therefore, that even a moderate agitation and mixing up of the warm and cold water might, in winter, reduce the temperature so much as to practically obliterate the warm belt at the bottom. But a severe storm, such as

the one referred to, might even cause such a variation in the position and direction of the tidal and other currents as to cause a direct flow of the cold inshore waters, to temporarily occupy the warm area, pushing further outward the Gulf Stream water. The result would, in either case, be a sudden and great reduction of the temperature, perhaps as much as 15° to 20°.* This could not fail to be very destructive to such southern species as find here nearly their extreme northern limits.

"It is probable, however, that these southern species, including the Tile-fish, were not thus destroyed further south. Therefore it is probable that in a few years they will again occupy these grounds by migrating northward, even if there be not enough left here to replenish their races."

While, as we have seen, there was apparently good reason in the opinion of many well-informed gentlemen to suppose the mortality among the Tile-fish was caused by cold water, there were others who, perhaps, were quite as firm in the belief that it was not cold, but unusually warm water which had destroyed the *Lopholatilus*.

The idea of the fish having been killed by coming in contact with the Gulf Stream seems, however, to have soon been abandoned, if we may judge by the following facetious allusion to it in the New York Times of April 22, 1882:

"Theories are still rife as to the reasons for the killing of these fish. The Gulf Stream notion, of the fish getting into hot water, not having a leg or a fin to stand on, others are now being ventilated. Said one wise skipper, 'There has been convulsions of nature under the seas. Now, you see, mates, these here loaferlatter lushisses is deep-sea fish. There comes the deuce to pay down below—their bladders gets busted, and up they comes like balloons. That's a pint no fish-sharp has studied up yet; don't you see?'"

In the Times of March 26, 1882, the theory of the fish having been destroyed by some sort of submarine volcanic action was advanced as follows: "Such an apparent wholesale destruction could only have arisen from some great natural cataclysm. In Southern waters, some years ago, a vast number of fish were found dead floating on the water. Studying the causes for this wholesale destruction, it was quite conclusively shown that there had been some volcanic eruption, which had taken place at the bottom of the sea, as a considerable quantity of a porous

* As I have previously stated, the fall in temperature, if such occurred, was probably due to an acceleration of the speed of the Arctic current, together with a presumable lowering of its temperature by the masses of ice off the Banks and Nova Scotia. This seems more plausible than to suppose that a commotion of the surface water might affect the greater depths. Were this possible it is to be assumed that the temperature of this region might undergo similar sudden changes of temperature each winter, since, as is well known, heavy northerly gales—as strong as those of February and March, 1882—are occurring every week or two, from November to April, in each year. Therefore, were this so, the Tile-fish would have scarcely existed in this locality long enough to have become so numerous as they were found in 1879–'80, and especially to reach an abundance such as was shown by the floating millions of March and April, 1882.

substance rose to the surface which was apparently composed of earthy matter, showing signs of having been heated or fluxed."

Mr. George E. Emory held the same opinion, and seemingly not aware that such a theory had been previously advanced, writes as follows in the Boston Daily Advertiser of April 5, 1882:

"I conclude these fish were not destroyed by any of the agencies lately suggested. Those floating thousands seen only represent the myriads left untouched by the local disaster and destruction. Probably a submarine disturbance of a volcanic character, set free mephitic gases which, reaching the fishes, produced a fatal asphyxia. This sort of fish-killing agency has been observed repeatedly in the vicinity of volcanic islands, as about Iceland and many other localities. A line of volcanic *stress* extends from Mount Erebus far below Terra del Fuego, through sea and land, away northwardly to the Aleutian Islands and the regions southward from Behring Strait. This line is intersected in Mexico by another line of pressure, extending away beneath the Atlantic Ocean to the Azores, thence to Franz-Josef Land, northeastward of Spitzbergen. Here is the old volcano of St. Thomas, now inactive, but known well in the fourteenth century. Tracing southwardly, we find the volcano Esk on Jan Mayen Island, and farther south is Hecla, in Iceland. At the west of the outer Hebrides the Rokol cliff and shoals are the remains of a great volcanic island, partly destroyed by an eruption in 1446. Thus extends the volcanic line of the Atlantic, and over a large part of the sea bottom along this line the mud is full of volcanic ashes. Deep-sea dredging has demonstrated the reality of the vast ash deposit."

This may have been the correct theory, but there were no reports of phenomena, which would lead us to suppose there had been anything like a submarine volcanic eruption near the locality where the Tile-fish were seen.

The following paragraph, which was extensively copied in the press, was thought by some to offer a possible solution of the problem, and to strengthen the position of those who had advanced the opinion that the fish mortality was due to volcanic action:

"BALTIMORE, *April* 17, 1882.

"Capt. G. H. C. Horner, of the German ship Stella, which arrived last Saturday from Bremen, gives an account of a singular phenomenon which he witnessed while on the way to this port. On the morning of March 18, Chief Officer Deboer had charge of the morning watch. The weather was serene and clear and the sea smooth and calm. The ship was going along at a rate of 2 miles an hour by the wind. At about 5.30 o'clock the vessel suddenly halted in her course, quivering from keel to keelson, and conveying the impression to those below that the ship had struck a rock. Captain Horner, who was below, looking over his chart, at once ran on deck to ascertain the cause of the shock, and, finding the weather clear and the sea tranquil, was puzzled. Neither the chief mate, who was on the quarter-deck at the time, nor the look-

out could account for the strange occurrence. The captain then ordered the heaving of the lead, but found no bottom at 100 fathoms. The pumps were sounded and the ship found to be tight. The shock lasted only half a minute, after which the ship went on as before. Captain Horner himself went aloft, but could discover no signs of any obstructions. He expresses the opinion that he had encountered a tremor or submarine volcanic eruption. The ship's position at the time was in latitude 37° 21′ north, longitude 23° 51′ west. He found the rate of the chronometer correct, observation being taken 56 minutes after the shock."

By reading the above extract carefully it will be seen that the Stella (if the account given is correct), was more than 2,000 nautical miles to the eastward of where the dead fish were seen, and it is scarcely reasonable to suppose that any influence could have been exerted on animal life even at one-tenth of that distance. Another thing which should not be lost sight of is, that the Tile-fish were seen floating at sea by the crew of the bark Plymouth on the 3d of March, fifteen days before the Stella received the shock which has been mentioned, and several other vessels also reported seeing dead fish previous to the 18th of March. It will therefore be seen that, even had this supposed volcanic eruption taken place much nearer the locality where the dead fish were noticed than it did, it could not be called the original cause of their destruction.

Then, too, if the mortality was due to volcanic action, why were not the *Gadidæ*, skates, and other cold-water species exterminated as well as the Tile-fish and other animals which Professor Verrill has said are considered tropical and subtropical forms?

It seems scarcely worth while to dwell any longer on this subject since a bare allusion to other possible reasons for the death of the Tile-fish will suffice.

That fish are often killed by disease, by troublesome parasites, by larger fish, and, perhaps, in the case of inland waters, by poisonous substances mingling with the streams, there can be no doubt.*

* The following accounts of the death of fishes, evidently from widely different causes, may be of interest in this connection: "The Harbor Grace Herald, (says the Gloucester Telegraph of August 10, 1853,) gives the following particulars of a mortality among the capelin, a small fish, which forms a large portion of the food of the Newfoundlanders:

"'It is a singular fact that within these few days past multitudes of dead capelin have been thrown ashore in the land-washes or seen floating on the water in various parts of this bay. What is still more extraordinary, and renders it probable that the creatures have been attacked with some internal disease, is the fact that thousands of them have been seen dying on the surface of the sea, their gill-covers distended and their under parts, between the pectoral and anal fins, discolored with eruptive spots.

"'In this state hundreds of barrels have been cast ashore in different parts of the coast.'" * * *

In the same paper of September 10, 1845, is the following:

"We learn that during the latter part of last week immense fields of small fish, floating dead upon the water, were to be seen in the harbor. They were of the kind called alewives, and in one place not less than an acre of them turned up their white sides to the sun. What was the cause of this mortality is unknown." (Baltimore Sun.)

But in the case of the *Lopholatilus*, there seems to be no reason whatever to suppose that any of these reasons could be assigned as a probable cause of death. The specimens obtained were said to be sound, wholesome, and handsome. When cooked, they were nutritious and remarkably palatable. They were not killed by other fish, for they were not mutilated. Neither could they have been destroyed by disease or by the ravages of parasites, for their appearance indicated the most robust health and freedom from injurious insects. Whatever the cause, it is evident that the fish were overtaken by some power which suddenly suspended their vital action, and transformed them almost instantly from active, vigorous animals into a mass of inert or dying forms floating helplessly at the surface of the sea.

E.—APPENDIX.

15.—REPORT UPON A CRUISE MADE TO THE TILE-FISH GROUND IN THE SMACK JOSIE REEVES, SEPTEMBER, 1882.

The area of sea bottom lying inside of the Gulf Stream, near the parallel of 40° north latitude, and between the meridians of 70° and 71° 20′ west longitude, in depths varying from about 90 to 125 fathoms, is where the Tile-fish (*Lopholatilus chamælonticeps*) has been found abundant during the past three summers, and this locality is known as the "Tile-fish ground," and here, as well as much farther south and west, dead fish of this species were seen floating in vast numbers at the surface of the ocean last March and April. The object of this trip was to ascertain by practical methods, and as complete a research as circumstances would allow, to what extent the Tile-fish had been depleted by the mortality of last spring, or if they had been practically annihilated in the region where they have heretofore been known to occur. The investigation of this subject was therefore a matter of unusual interest, whether we look at it from a scientific stand-point or whether we take into consideration how much benefit might result to those engaged in the fisheries, should the Tile-fish be found in anything like its former abundance, and its commercial value be established. This species has been pronounced a most excellent food-fish by competent judges, and there is reason to expect that its market value might have been fully equal to that of many of our choice fishes had sufficient numbers been taken to place it before the public as an article of food.

In obedience to the tenor of your orders that I should proceed to the Tile-fishing ground and ascertain the presence or absence of the *Lopholatilus chamælonticeps*, I have the honor to submit the following report:

I left Gloucester September 15, 1882, to join the schooner Josie Reeves, which was then at Greenport, Long Island, waiting my arrival. I had previously forwarded the fishing apparatus, trawl lines, &c., that I had

prepared for the trip. My intention was to have started on the 14th, but the prevalence of an easterly storm, accompanied by high winds, together with some difficulty I had in obtaining the lobster-pots, delayed my departure.

Going by the Fall River line, I reached New York on the morning of the 16th. On arriving at the city I went at once to the office of Mr. E. G. Blackford, Fulton Fish Market, in order that I might learn of him whether all the tanks, jars, and other materials for preserving specimens (which articles were sent to his care) had been forwarded to the smack. All of these details had been carefully attended to by Mr. Blackford; and I learned from him that, besides the provision made for the preservation of material in alcohol, there was sufficient ice on board of the schooner for the refrigeration of our bait and any number of fish we were likely to capture.

Having ascertained these facts, I went by the afternoon train (the first one leaving New York) to Greenport, where I arrived at 6.40 o'clock in the evening. Mr. Barnet Phillips, who accompanied us on the cruise and who had joined the smack in New York, and Captain Redmond, skipper of the Josie Reeves, met me at the depot. I went with them on board the schooner then lying at the wharf where the menhaden steamers rendezvous when in port.

I learned from Captain Redmond that all the material for the trip, with the exception of the lobster-pots which I had sent from Gloucester, had been received and was snugly stowed away on board of the smack. However, owing to the prevalence of rough weather during the preceding four or five days, no menhaden had been caught, and therefore it had been impossible to procure a supply of bait for the cruise. It is true, perhaps, that bait might have been obtained from the weirs in the vicinity of Sandy Hook when the smack left New York, but to have taken it then, with a storm of uncertain length impending, would have been very unwise, since the probabilities were that it might be unfit for use before a chance offered to go to sea. Under the circumstances, there was nothing to do but to wait until Monday.

Captain Redmond thought our best chance of obtaining bait would be from the weirs in the vicinity of Greenport. Therefore, on the next day, the 17th, we procured a team and drove to all the fish traps which could be reached. We found, however, that the prospect of getting "bunkers" from the pounds was not good, for most of them had been either torn up or so badly injured by the storm that there was little chance of securing enough menhaden to answer our purpose. The only thing that could be done under the circumstances was to wait until the fishermen went out in the sound, when, if the fish "played" well, we might get bait from the seining gangs.

At daylight on Monday, the 18th, there was a smart southerly breeze with indications of rain. The steamers had started between midnight and dawn, and the sailing gangs, which were out early, looking for fish,

finding the wind too strong down Gardner's Bay, began working up by Greenport under reefed sails, towards the more sheltered waters of the Great Peconic Bay. Altogether the prospect of getting a supply of bait was not promising for that day. Towards noon, however, the appearance of the weather changed very much, and the afternoon was fine, with a moderate southwesterly wind.

We were reluctantly compelled to wait for our lobster-pots until the arrival of the steamer from New London at 11.30 o'clock a. m. We then got under way, but seeing no indications of the presence of menhaden as we ran down Gardner's Bay, we decided to work up the sound, feeling confident that we should have a better chance there to meet the fleet of steamers that had gone in that direction; there was also a probability of getting menhaden from the pounds on the Connecticut shore. When off Cornfield light-ship we saw several "bunches" of "bunkers," but as there were no seiners in sight we kept on our way. The pounds along the shore, which we approached quite closely, had met with the same fate as those at Greenport, being rendered unfit for fishing by the late gale. At about 8 o'clock in the evening, having reached the vicinity of Guilford, where there is an oil and guano factory, we came to anchor near Falkner's Island, expecting to have an opportunity the next morning to secure bait from some of the fishing gangs which were thought to be at that place. Another reason for our anchoring was that the tide had turned against us, and, the wind being light, we could not hold our own under sail.

The morning of the 19th was calm and fine, and after daylight we saw numerous "bunches" of menhaden playing at the surface near where we lay anchored. At that time there were the two sloops of a "sailing gang" lying at anchor close inshore, but they did not get under way until some time after sunrise, when they began working off shore, taking what advantage they could of the occasional "cat's-paws," which, later, became more steady, though the wind continued very light. The boats gained little, however, and feeling anxious to secure their assistance in procuring bait, and fearing that they might go in some other direction if the wind breezed up, I, with two of the smack's crew, started to board them in one of our dories. We had about 2 miles to row, but the distance was soon passed over, and we boarded the larger of the sloops—the one having the fishing gang on board—the other being the carryway boat.

Having first told the captain of the gang that there seemed to be an abundance of fish near our vessel, I asked him if he would sell us bait enough for our trip, telling him for what purpose the cruise was undertaken. Though entirely willing to furnish us with bait, so far as he was personally concerned, the captain explained that he was not permitted to sell any menhaden for such a purpose, but said that if I would go ashore and get the consent of Captain Fowler, one of the proprietors of the factory, and who, we were told, is president of the Oil and Guano

Association, he would most gladly supply us with bait. Accordingly we went to the factory, but learned that Mr. Fowler had just driven off to "town" (Guilford) and would not return for the day. The foreman in charge of the factory, to whom we explained why we landed, thought there would be no objection to our procuring bait, but was not disposed to assume any responsibility.

As nothing further could be done we returned to the Josie Reeves, and, the wind having breezed up slightly in the interim, we got under way and stood in the direction of the sloop we had boarded, and which at this time had worked off on the ground a little over a mile distant from us. Soon after filling away we saw the boats out, setting the seine, and the breeze being too light to gain much in the vessel, I started off again with two of our men to buy what bait we needed if the seiners succeeded in making a good catch. A fair-sized "bunch of fish" had been surrounded, and our men helped to gather in the twine during the "drying in" process. The "boss" of the gang thought he had from fifteen to twenty thousand fish in the net, and there was every prospect of securing the entire lot, when, just as the men were ready to "bail out" the fish, a large hole was torn in the seine (due to the rottenness of the twine or the bite of a shark or dog-fish), and the bunkers went streaming out through the "tear," leaving only a few—perhaps one-tenth of the whole—which were hastily gathered in one corner of the bunt, and scooped on board of the carryway boat. The skipper had consented to supply us with bait, on condition that I should write a letter to the owners of the factory explaining the purpose for which it was obtained.* The failure to get this school was as much a disappointment to us as to the fishermen themselves, possibly even more so, for we were very anxious to improve the favorable wind to run down the Sound, and also felt some uncertainty about getting bait before night.

However, another set was made by the crew of the sloop, but the result added but little to the first catch, the whole amounting to only 2,200 fish, which we took on board and packed in ice. By this time it was getting late in the afternoon, the fish had stopped schooling, the sailing gang manifested a disposition to go in harbor, and a loaded steamer, bound to Greenport, which we unsuccessfully tried to head off, paying no attention to our signals, there seemed little probability of getting the rest of our bait before night. But a sharp lookout was kept for homeward-bound bunker steamers, and at 5 o'clock p. m. we were for-

* This letter was written and addressed to Messrs. Fowler & Colburn, Guilford, Conn., as follows: "Being in want of menhaden for bait wherewith to make a fishing trip to the grounds lying inside of the Gulf Stream, in the interest of the United States Fish Commission, we have applied to the captain of the sloop Fanny, who has kindly consented to furnish us with a supply on condition that I shall write this letter of explanation to you. I trust you will commend his action in this matter, since we have been prevented from obtaining bait for several days on account of the recent rough weather, and because of the importance of this investigation, which might be much delayed, if not rendered abortive, should we be unable to procure bait now."

tunate enough to meet with the William A. Wells, on her way to Greenport with a cargo of menhaden. The captain, who knew the Josie Reeves, and understood why she was there, very kindly stopped his boat and sold us 2,000 fish at $5 per thousand. He also took our mail.

We then filled away and ran down the Sound with a brisk southerly breeze, carrying all of our light sails. At 8.40 p. m. passed Little Gull Rock and at 10.30 p. m. Montauk Point light bore SW. by W. about 5 miles distant. At that time we hauled to, steering a S.SE. course, and as there was some head sea and the wind had freshened, we took in the balloon jib and staysail.

The morning of Wednesday, the 20th, was fine, with a brisk breeze from S.SW. About 8 o'clock, however, it was foggy, but soon after it cleared off, and the weather continued fine throughout the day, though the wind was somewhat variable, backing southerly for two or three hours at a time, and then hauling back again.

At sunrise all hands were called, and we began making preparations for setting the gear, and during the forenoon we baited a cod and haddock trawl, each having 1,000 hooks. We thought it possible in the morning that we might get to the Tile-fish ground early enough to make a set with the trawls, but the wind being moderate and variable in the afternoon we did not reach deep water until 3.55 p. m., when we sounded in 118 fathoms, our position at that time by dead reckoning being 40° 4′ north latitude, and 70° 30′ west longitude, about a mile from the position where the Fish Hawk found Tile-fish abundant August 23, 1881. The day was too far advanced, however, for us to set the trawls, so we hove to for the night.

A short time before reaching deep water (shortly after 3 o'clock) we saw several fin-back whales. A little after 4 o'clock we noticed three or four schools of small fish, which were apparently about the size of large mackerel. At times they showed a ripple like mackerel or herring, and very frequently many of them would spring from the water together, making long dolphin-like jumps. We ran for the schools in hopes to approach them near enough to find out what species the fish were, but they sank before we got close enough to them, and a troll-hook which we put out failed to catch any.*

The evening was fine, with brisk S.SW. wind. We lay to under mainsail and jib with head to the eastward during the first half of the night, after which we jogged the opposite way.

Thursday morning, the 21st, was overcast, with a moderate S.SW. breeze, but after sunrise the weather cleared off beautifully with a slight increase of wind.

At daylight we set the trawls under sail, beginning in 160 fathoms and running the gear northwardly towards shoaler water. After the trawls were out we sounded at the lee ends, getting a depth of 135 fathoms, the bottom being mud, sand, and broken shells. Our position

* It is probable that the fish we saw were mullet.

was latitude 40° 3′ north, and longitude 70° 28′ west. Captain Redmond went in one of the dories (as he did during the whole time we were on the ground), leaving me to manage the smack with the assistance of the cook, while Mr. Phillips busied himself in taking notes on this method of fishing, which he now saw for the first time.

Being entirely unacquainted with the strength of the current in this locality, we put four buoys on each trawl—two on an end—to make sure that the gear should not be lost by the submergence of the kegs. We found, however, after the trawls were set, that there was only a moderate tide setting to leeward in a northeasterly direction, and apparently only at the surface.

We began hauling the trawls at 8 o'clock a. m., and picked up the last dory at 10.15. Only three fish were caught. These were a hake (*Phycis*), a grenadier (*Macrurus*), and a whiting, or silver hake (*Merlucius*).*

After getting the boats on board we ran to the westward, the men in the mean time being busy in baiting the trawls, which we set again at 2.30 o'clock p. m. in from 130 to 150 fathoms,† our position being latitude 40° 2′ north, longitude 70° 41′ west.

The gear was hauled late in the afternoon. We caught about twenty hake (*Phycis*), four or five silver hake (*Merlucius*), several skates (*Raia*), of which we saved two specimens, and three handsome fish of a species which I had not previously seen,‡ besides a limited number of invertebrates. All of the largest fish were iced, as well as one of the rare ones, which we were in hopes might prove of special interest, and which we preferred to keep in ice, so that it would retain its color. The other two were put in alcohol, as also were the invertebrates.§

Owing to the fact that we were uncertain about the strength of the current in the morning, and had so little time for the afternoon set, we did not put out any of the lobster pots. It is, perhaps, proper to remark here that fishing, as we were, under sail, and exerting ourselves to the utmost to make as many trials as possible in a given space of time, little could be done with lobster pots in deep water, though it is entirely reasonable to suppose that they might be set from a vessel at anchor

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*These, with the exception of the first, were put in jars, with other material (invertebrates), and labeled "Lot No. 1."

†In all cases the trawls were set at right angles to the trend of the ground, which here extends nearly east and west, sloping quite rapidly to the southward, so that a trawl, being nearly a mile long, might be in 150 fathoms where its southern end lay, while at the northern extremity there would not be more than 120 or 130 fathoms. It seemed desirable to place the gear so that, as far as circumstances would permit, various depths might be reached, since it often happens that some species of fish which may occur in great abundance at a depth of, say, 130 fathoms or more, can be rarely taken in shoaler water, while other kinds would be found most plentiful where it was not so deep.

‡This species has since been identified as the *Sebastoplus dactylopterus*. Immature specimens had previously been found on our coast, but no adults had been taken. It also occurs in the Mediterranean and at Madeira.

§This collection was labeled "Lot No. 2."

on a hard bottom with excellent results. When making "flying sets," to "try the ground," it is desirable that the gear shall sink as soon as possible, in order that it may soon be hauled in again. Lobster pots, of the ordinary pattern are somewhat unwieldy and sink slowly, and the necessity for speedy action when fishing under sail makes it desirable to pull them in again before they have been sufficiently long on the bottom to secure the best results.*

After hauling our trawls we ran to the westward about ten miles and hove to for the night, with the "jib to the mast."†

During the day the wind had backed easterly, and at sunset was southeast, blowing a moderate breeze. The weather at that time was fine, but the sun "setting in a bank" gave us reason to suppose that it might be less favorable on the next day.

Friday morning, the 22d, there was a fresh southeast breeze, with indications of stronger wind, and possibly rain before night. Orders had been given the previous night to exercise considerable care to keep our position, and so well was this attended to that at daylight we sounded in 140 fathoms. At this time the men were called out to bait the gear. One man was sick, therefore we set only one string of trawl, which we put out at 8.30 a. m. in 125 fathoms, latitude 40° 1′ north, longitude 71° 2′ west, by dead reckoning.

We hauled the gear at noon, three men going in the dory. At this time there was a strong and increasing wind with a choppy sea going. As there was little probability of its moderating enough to set again in the afternoon, we took the dory on deck, took care of the catch, and stowed the trawls below.

On this occasion ("Lot No. 3") we caught twenty-five or thirty hake, several silver hake, and eleven specimens of the remarkable red fish which we had first seen the day before. One of the latter was so badly eaten by slime eels that it was thrown away. Several of the finest specimens were put on ice, while the rest, with the exception of two, which we ate, were put in alcohol. Mr. Phillips, believing the species might be new to science, and deeming it an important matter to determine its qualities as a food-fish, suggested that we should eat one, as

*On the ground where we were fishing it would probably have made little difference, for the slime eels (*Myxine*) were so plenty that they invariably consumed the bait when the pots were set at a later date, and it is very likely that their presence in such great numbers would have prevented the entrance of other and more desirable species, which might otherwise have been captured.

†This is a favorite method of heaving a vessel to on the fishing-ground among the market fishermen from New York to Portland, Me. The jib is trimmed flat, so that its clew is nearly amidships, or it is held in about the same position by a "tail rope" from the weather bow. The helm is then secured in such a manner that the vessel, by lying first on one tack and then on the other for greater or less time, will hold her position much closer than would be expected. However, to accomplish this successfully requires the peculiar knowledge of these vessels, and the skill to manage them possessed by the fishermen, and which only long experience can give.

no one could say when another opportunity might offer to obtain fresh specimens. Fully concurring in his opinion, I had two of them cooked, and we found them most delicious, with firm crispy flesh, and a delicate flavor that would be hard to equal.

In the lobster pot only slime eels were taken. These were placed in alcohol.

It is perhaps worthy of remark that in all the fish which were eviscerated not the least trace of food was found, and I am at a loss to know why species so voracious as the hake, whiting, and others, which we took, should be found in a locality where there is evidently little food to be obtained.

The scarcity of sea-birds might be cited as an indication of a limited amount of small fishes, or other forms near the surface. However, an occasional hag (*Puffinus*) was seen, and several varieties of jægers, which appeared more common in this region than other forms.

At 1 o'clock p. m. we kept off and ran to the westward 15 miles by the log.* At 3.45 p. m. we sounded, and having got a depth of only 50 fathoms, let the vessel jog under mainsail and jib, on the port tack, slowly head-reaching to the southward. At sunset there was less wind and occasional light showers. By the exercise of much care, and sounding frequently during the night, the vessel was kept on the edge of the ground so closely that at 5 o'clock on Saturday morning, the 23d, we were in 150 fathoms At this time there was a moderate S. SE. breeze, but considerable ground swell, which increased somewhat later in the day. The sky was overcast with broken clouds, though there was no appearance of thick weather.

All the men were called to bait the trawls at dawn. Being anxious to make two sets during the day, and knowing that we could not if we set two trawls at once, we baited only one string—a thousand hooks—which we set between 8 and 9 o'clock a m. in from 100 to 125 fathoms; latitude 39° 54′ north, longitude 71° 22′ west. After the trawl was set we left one of the dories fast to the lee end, since the ground swell rendered it difficult to see a buoy flag any distance. We began hauling the gear at 11 o'clock, a dory going to each end of the trawl, and shortly after noon the men had finished the work. But little was taken on this haul—"Lot No. 4"—it consisting of a few hake, three dogfish (*Squalus*), and a few invertebrates on the trawl, and nearly a bucket full of slime eels (*Myxine*), and a single crab in the lobster pot, which we had fastened near one of the anchors.

As soon as we had finished hauling we kept off southwest by west, and ran a little over 5 miles on that course, when, having got a depth of 110 fathoms, we set one of the trawls, which we had baited during

* I take this occasion to mention that the captain of the yacht "Madeline," which lay in winter quarters at Greenport, kindly lent us the yacht's patent log, which we found very serviceable. The log was returned through Captain Redmond, with a letter of thanks and acknowledgment of the favor conferred.

the forenoon while the first one was out. The position of this set was, latitude 39° 50′ north, longitude 71° 25′ west. The trawl was hauled at 4.30 p. m. by three men, who went in one of the dories. This was necessary, as one of the crew was ill, and also because at this time the increasing wind and sea made the hauling of the trawl a matter of some difficulty for two men to accomplish. The catch, which contained nothing of interest, consisted of about thirty hake, and a single specimen each of dogfish (*Squalus*) and monkfish (*Lophius*), all of which we iced.

The investigation having now continued uninterruptedly for three days, and 50 miles along the edge of the ground having been tried over, with not the slightest indication of the presence of the Tile-fish, to search for which was the object of the trip, and the appearance of the weather being such that strong winds and a rough sea might be expected for the next two or three days at least,* I concluded that nothing could be gained by staying longer on the ground. One reason for this decision was that our bait, though we had had it on board only five days, had already begun to show signs of deterioration, and it was obvious that, should we have rough weather for three or four days, which was very likely to occur at this season, the menhaden would be entirely unfit for use, and the cruise would have to be given up then even if there should be a return of fine weather. The chances, therefore, were that a longer stay would only add to the expense of the trip without the attainment of any additional results. Other important business, which required my attention, also made it extremely desirable that no time should be wasted. Besides all this the time for which we had chartered the smack had nearly expired, and Captain Redmond was very desirous of resuming his business of lobster carrying, since he feared his trade might be injured by a longer absence.

I had hoped to continue the investigation for eight or ten days at least, and to have prosecuted the research some distance farther south, though the probabilities are that little more could have been accomplished so far as catching Tile-fish is concerned. Nevertheless, it would have been more satisfactory if the weather had permitted us to stay long enough to settle all doubts as to the presence or absence of the *Lopholatilus* within certain limits. However, this not being practicable for the reasons given above, it was decided to run for the land. Accordingly we kept off at 5 o'clock p. m. The wind at that time blew fresh, and continued strong and steady through the night. At 2 o'clock Sunday morning, September 24, we made Block Island light. After getting nearly abreast of the island we hauled up more, and, passing through Buzzard's Bay and Quick's Hole, reached Wood's Holl about 9 o'clock

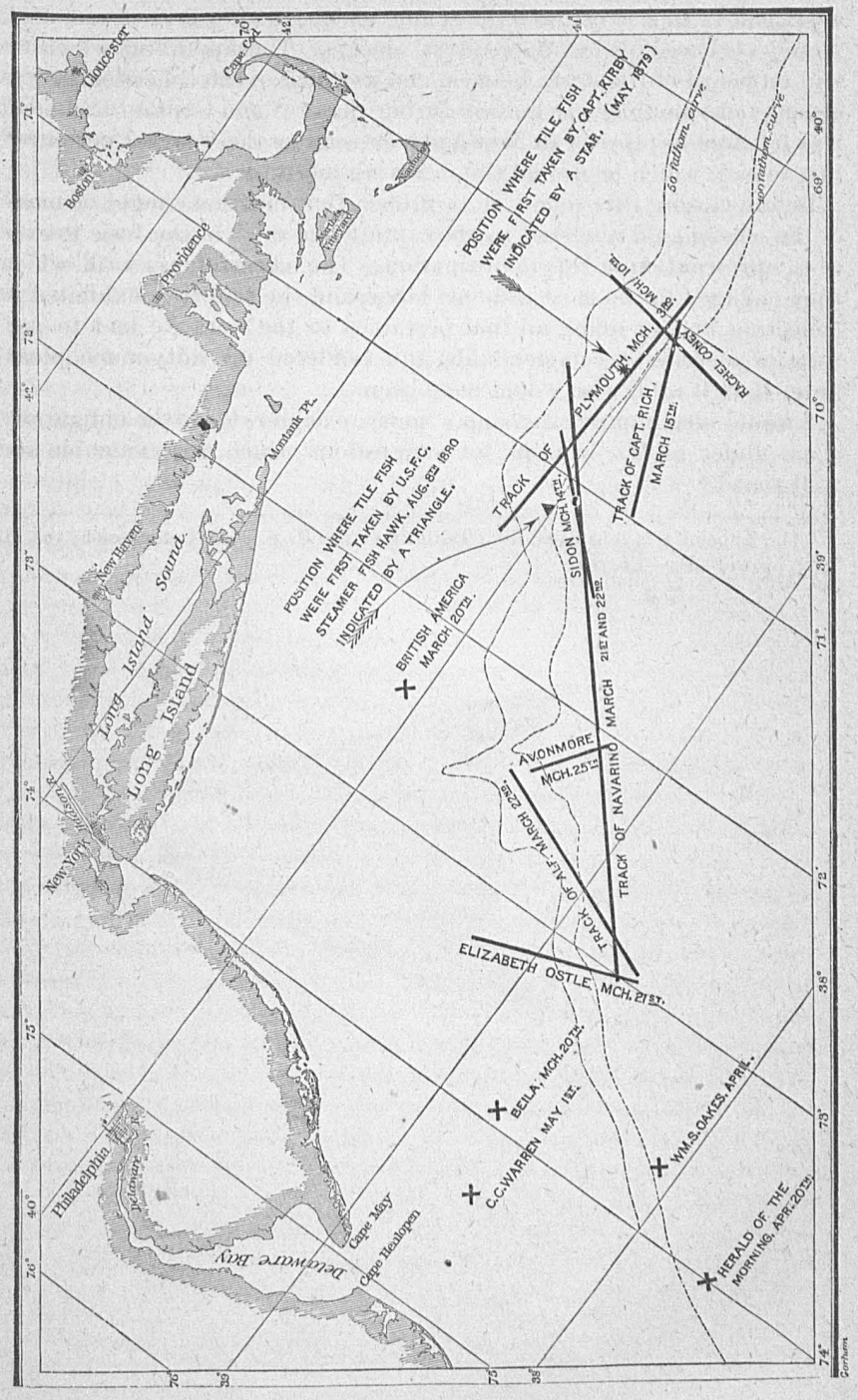
* The spell of rough easterly weather that began at this time continued uninterruptedly for eight days, and there is little probability that the least chance would have offered to set trawls, especially when we consider that a large fleet of mackerel schooners was kept in harbor during all this time, and many vessels engaged in the cod and halibut fisheries were prevented from sailing by the same cause.

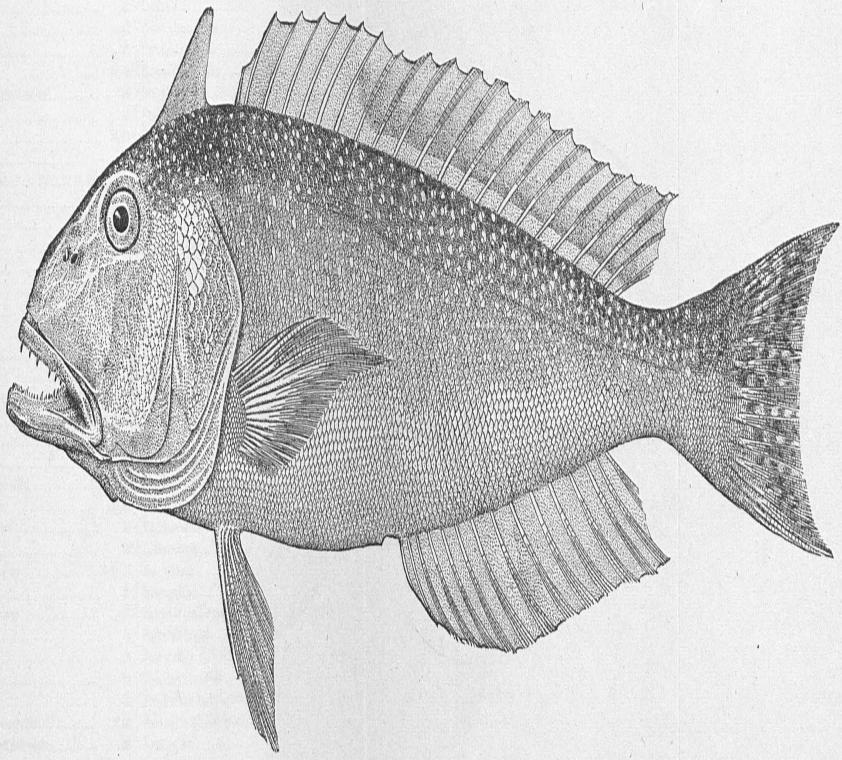
a. m., just in time to escape a dense fog, which, coming in from sea, completely obscured all but the nearest objects. The apparatus which we had on board of the Josie Reeves, and as much of the collection as was considered valuable, was landed during the day, and Captain Redmond was left free to proceed to New York as soon as the weather permitted him to sail, which he did on the following morning.

Before closing this report it is proper that mention should be made of the efficient aid rendered by the captain and crew of the Josie Reeves in the prosecution of this investigation. The cheerfulness with which they engaged in the most arduous labor, and the zeal they exhibited in collecting and in doing all that pertained to the work we had to perform, was certainly commendable, and rendered my duty much pleasanter than it otherwise would have been.

I would also improve this opportunity to acknowledge the obligations I am under to Mr. Phillips for suggestions which were valuable and well timed.*

* The Appendix is reprinted from Bulletin of the U. S. Fish Commission, vol. II, 1882, pp. 301-310.—EDITOR.


Gloucester
Boston
Cape Cod
Providence
New Haven
Long Island Sound
Long Island
Montauk Pt.
New York
Philadelphia
Delaware Bay
Cape May
Cape Henlopen
Nantucket
POSITION WHERE TILE FISH WERE FIRST TAKEN BY CAPT. KIRBY INDICATED BY A STAR. (MAY 1879)
50 fathom curve
100 fathom curve
RACHEL CONEY
PLYMOUTH, MCH. 13TH.
TRACK OF CAPT. RICH, MARCH 15TH.
TRACK OF
SIDON MCH. 14TH.
POSITION WHERE TILE FISH WERE FIRST TAKEN BY U.S.F.C. STEAMER FISH HAWK. AUG. 8TH 1880 INDICATED BY A TRIANGLE.
BRITISH AMERICA MARCH 20TH.
AVONMORE MCH. 25TH.
OF ALT. MARCH 23RD.
TRACK OF NAVARINO MARCH 21ST AND 22ND.
ELIZABETH OSTLE, MCH. 21ST.
BEILA, MCH. 20TH.
C.C. WARREN MAY 1ST.
WM. S. OAKES, APRIL.
HERALD OF THE MORNING, APR. 20TH.



The Tile Fish (*Lopholatilus chamaeonticeps*).

INDEX.

NOTE.—The references are to page-figures in brackets.