DEPARTMENT OF COMMERCE AND LABOR
BUREAU OF FISHERIES
GEORGE M. BOWERS, Commissioner

UNUTILIZED FISHES AND THEIR RELATION TO THE FISHING INDUSTRIES

Bureau of Fisheries Document No. 622

WASHINGTON
GOVERNMENT PRINTING OFFICE
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By Irving A. Field

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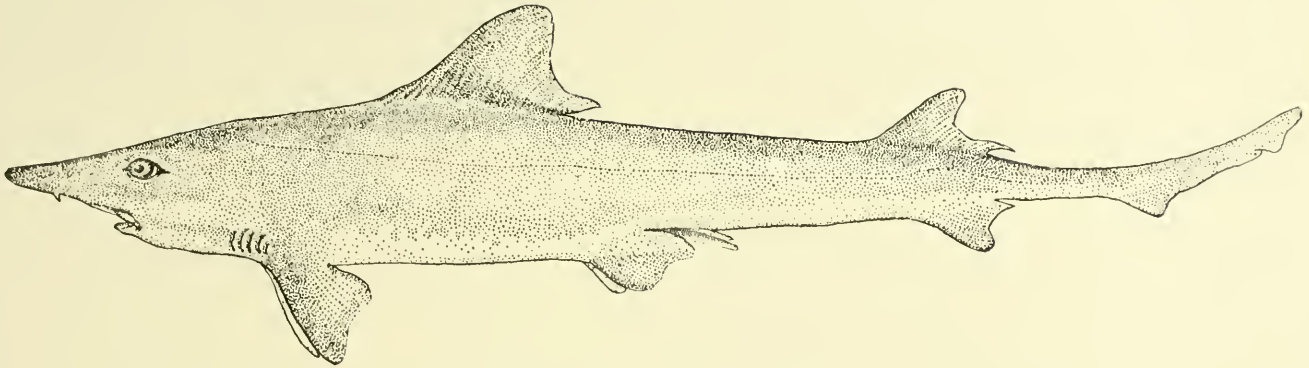
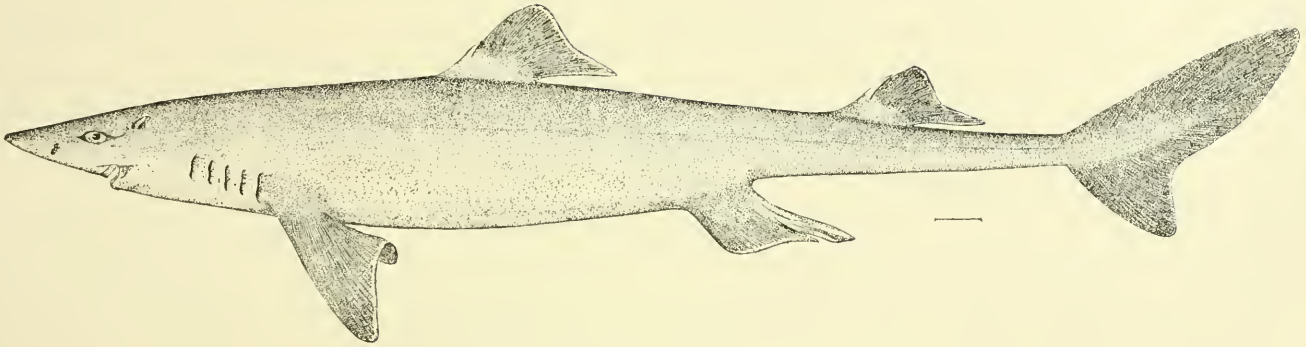


1. SMOOTH DOGFISH (MUSTELUS CANIS).



2. HORNED DOGFISH (SQUALUS ACANTHIAS).

UNUTILIZED FISHES AND THEIR RELATION TO THE FISHING INDUSTRIES.

By Irving A. Field.

INTRODUCTION.

The destruction of food fishes by fishes of little or no commercial value is a subject of obvious importance to the fishing industries. To preserve for his own uses the species he values, it becomes necessary for man to control the depredations of his rivals.

Under normal conditions the balance among the different forms of life is maintained by natural laws. Where great destructive forces are at work upon a species that species will be found to be endowed with great powers of reproduction. The lobster, for example, wholly defenseless in its early stages, and even when mature the prey of a host of enemies, is able to perpetuate itself because of its enormous fecundity, there being a biennial production of about 15,000 eggs by each mature female lobster. The smooth dogfish, on the other hand, a most destructive enemy of the lobster but itself comparatively free from enemies, produces from four to a dozen young at a time, and these are practically adult in form at birth.

The natural balance, however, is seriously disturbed by man, for whose purposes the supply of one species is exhaustively drawn upon, while another, perhaps destructive, form undergoes no diminution. To offset the drain upon the valuable species, close seasons have been created to afford them protection during the breeding periods, fish hatcheries have been established to replenish their numbers, and sometimes the destruction of their natural enemies has been sought by means of bounties or through the introduction of parasites. Effective methods of lessening the destructiveness of the useless marauders, however, are the important factor lacking in present conditions. While the struggle for existence has grown constantly more severe for the lobster, which has man as a new enemy, the smooth dogfish has continued unmolested, and thus increased in numbers. And so with the other commercial species and their nonvalued enemies. With the fish culturist's aid and the legislator's care a species may be able to maintain itself even against the combined agencies of its natural enemies and man; but the struggle is increasingly difficult, and it is ultimately hopeless in some cases. The possible advantage

to the fishing industry through the elimination or control of the greatest destructive factor remains, moreover, always of untold immensity.

PLAN AND METHOD OF INVESTIGATION.

The relative value or uselessness of fishes for man's purposes is determined not only by the possibilities of direct economic utilization, but by the interrelations of the species as well. A knowledge of their feeding habits, therefore, is of the utmost importance in an effort to devise means of controlling the destructive enemies of valuable forms, and it is through study of this subject that the present investigation seeks its end. The work, which was undertaken for the Bureau of Fisheries at its Woods Hole laboratory in 1902 and continued through succeeding years to 1906, has consisted of observation of the feeding habits and examination of the food of seven predatory fishes common in the vicinity, and of the horned dogfish in addition, and these results form a basis for suggestions designed to lead to a lessening of the destruction.

The method of investigation was to secure as many as possible of the valueless fishes in question from various localities in the vicinity of Woods Hole, and immediately after capture to preserve the entire contents of the stomach or the whole digestive tube of each. A separate dish received this content from each fish, and over it was poured a formalin solution of about 2 per cent strength. Further action of the digestive juices was thus prevented, and the material was preserved for study at convenience.

Such fishes as the shark and dogfish were taken almost exclusively from the traps of the Bureau of Fisheries set in Buzzards Bay. A few sand sharks were taken from the Marine Biological Laboratory trap in Vineyard Sound, and a dozen or more smooth dogfish were caught by hook and line or by a trawl set in Buzzards Bay. The other species here discussed were caught in a 150-foot seine, set by two or more men with a boat about a favorite haunt of the fishes, which were then drawn to shore and the desired specimens sorted out. From the sharks and dogfishes, which feed on large living forms, only the contents of the stomach were preserved, since in these fishes by the time food has entered the spiral valve it has become so ground up and so far digested that it is rarely possible to identify anything.

At the laboratory the various ingredients composing the contents of each stomach, or whole digestive tract, as the case might be, were ascertained quantitatively and, when possible, the total number of any given sort of animal which had been swallowed was recorded. For the smaller fishes this meant a minute microscopical examination of the entire contents of the digestive tube. Where a given species of animal was found in too great abundance or too badly preserved

to be counted exactly, the relative terms "little," "moderate," and "much" were used in the record, "little" meaning that there was sufficient quantity to be identified, "moderate" that at least one-fourth of the stomach was filled, and "much" that the stomach was well filled with the species or substance indicated. The data thus obtained were tabulated to show the date and locality of capture of the fish, number of specimens (fishes) examined, and the number of specimens containing each kind of food. The form of tabulation adopted is that of Dr. Peck (1896), excepting the addition of the locality.

REVIEW OF LITERATURE OF THE FOOD OF FISHES.

Notwithstanding the importance of the subject, study of the food of fishes has not been very extensive, and the literature is very meager. Verrill and Smith (1873) have given a list of invertebrate-animals found in the stomachs of fishes taken in Vineyard Sound. Peck (1894) made a study "On the food of the menhaden," which species he found to be entirely dependent upon micro-organic material filtered from the water by means of specially modified gillrakers. In a later paper (1896) he shows that ultimately all fishes are dependent, either directly or indirectly, upon this micro-organic material. He characterized the food of the squeteague by this concrete instance:

> On the morning of July 23 there was taken a large specimen whose stomach contained an adult herring. In the stomach of the herring were found two young scup (besides many small crustacea), and in the stomach of one of these scup were found copepods, while in the alimentary tract of these last one could identify one or two of the diatoms and an infusorian test among the mass of triturated material which formed its food. This is an instance of the universal rule of this kind of food; the squeteague captures the butterfish or squid, which in turn have fed on young fish, which in their turn have fed upon the more minute crustacea, which finally utilize a microscopic food supply.

These two papers of Dr. Peck are probably the most serious contributions that we now have on the food of fishes. Peterson (1893) devotes a portion of one chapter in his paper to the food of the flatfishes. Kendall (1898) treats of the food of a few of the more important members of the cod family, commercially the most valuable group of fishes found on our Atlantic coast. His purpose was to explain "the phenomena of the withdrawal of certain fishes from a region where they have been abundant, the presence of large numbers one year and their scarcity the next, their disappearance for long periods and their sudden reappearance." The paper consists chiefly of a record of an examination of the stomach contents of numerous specimens taken on the shores of the New England States and the Canadian maritime provinces. McIntosh (1899) in his introductory chapter gives a "general review of the resources of the sea and the influence of man thereon." He emphasizes Dr. Peck's

idea that there is a complex cycle involving the whole series of marine forms, from the minute micro-organic matter (animal and vegetable) to the fishes. Scott (1899) gives a few notes on the food of young fishes which frequent the British coast in the vicinity of Piel. Linton (1901) in his Parasites of Fishes of the Woods Hole Region has a record of food found in the alimentary tract of the fishes he examined for parasites. Scott (1902) made a special study of the food of small and immature fishes, and describes also the food of several larger species. He shows that minute crustacea form the chief constituent in the food of the young of many species which when adult live mostly on other organisms.

These researches on the food of fishes, it will be observed, vary greatly in character and purpose. In one case the object was to find new species to add to a local faunal list; in others it was to find out the primary food basis of the fishes; another author wished to explain irregular and sudden migrations of fishes, and still another studied the food in order to study the parasites of fishes. Much therefore remains to be learned about a most important factor in many scientific and economic questions.

THE SMOOTH DOGFISH.

CHARACTERS AND DISTRIBUTION.

The smooth dogfish (*Mustelus canis*) has a slender, elongated body, tapering from the dorsal fin back to the slender heterocercal tail. The color is a uniform slaty gray on the back and sides and a light pearl gray on the ventral surface. The skin is thickly beset with minute, hard, sharp tubercles—the placoid scales; to the hand passing forward over it the sensation is that of feeling a fine sandpaper. The head, broad and depressed, terminates in a moderately sharp snout. The mouth is small and situated on the ventral side of the head. It lies transversely, somewhat crescentic in shape. The teeth are flat and pavement like, well adapted for crushing rather than for seizing and holding prey. A pair of nostrils open on the ventral side of the head, one in front of each corner of the mouth. Two round small apertures, the spiracles, open dorso-laterally, one behind each eye. There is no operculum, the branchial clefts opening as five pairs of slits, which lie in a vertical position on each side of the neck. There are two dorsal fins and two sets of paired fins, the anterior pair, or pectorals, being situated ventro-laterally just behind the head, and the posterior pair, or pelvic fins, being located on the ventral side just anterior to the cloacal opening. In the male the inner sides of the pelvic fins are modified into stiff fleshy rods called claspers. The average length of the smooth dogfish is about 3 feet, but occasionally

specimens are taken that measure as much as 5 feet. The distinctive characters of the species are shown in figure 1, plate I.

The smooth dogfish is of wide distribution. It occurs in great numbers along our Atlantic coast from Cape Cod to Florida, and is found in the Pacific, along the coast of California. It abounds also on the Atlantic coast of southern Europe and in the Mediterranean.

BREEDING HABITS.

The mode of reproduction in this species is very different from that of most other fishes, fertilization being internal. The eggs develop inside of the egg tubes, and the young when born are similar to adults except in size. They are vigorous and swim about actively. A female smooth dogfish, which was opened in the summer of 1904 by Dr. Linton at the Fisheries' laboratory at Woods Hole, contained 8 young, which measured about 12½ inches each. They were about ready to be born. I have never found more than 12 embryos nor less than 4 in a pregnant female. How long a time intervenes between fertilization and birth of the young has not been determined.

FOOD.

Several writers in past years have incidentally devoted a paragraph to the food of the smooth dogfish. None of them, however, has made a thorough study of the subject. Verrill and Smith (1873) state:

> Several specimens caught at Woods Hole contained lobsters (*Homarus americanus*), spider crabs (*Libinia canaliculata*), rock crabs (*Cancer irroratus*).

Goode (1884) gives merely the general statement that "it feeds upon crabs, lobsters, and other bottom-loving invertebrates."

Linton (1901) says:

> The alimentary canals usually contain crabs (*Panopeus, Platyonichus, Cancer, Libinia*, etc.); squid, annelids, and fish have also been noted.

In the Standard Natural History, vol. III, appears the statement:

> It is harmless and feeds on the crabs and shells which abound on the bottom in favored localities.

EXAMINATION OF DIGESTIVE TRACTS.

The accompanying table is in general agreement with all that the foregoing writers have said concerning the food of the dogfish, except that the species is not harmless. A careful study of the table, which gives the results of examinations of 388 specimens, will show not only that the smooth dogfish is destructive to crustaceans in general, but that it is especially the enemy of the valuable American lobster. About 16 per cent of the 388 fishes contained lobster in varying quantities, from a leg or chela up to two whole lobsters measuring as much as 7 inches in length.

STATEMENT OF THE FOOD OF

NOTE.—Figure outside parenthesis denotes number of smooth dogfish; quantity

Date.	Locality.	Specimens examined.	Number of stomachs containing—					
			Rock crabs.	Spider crabs.	Lobsters.	Menhaden.	Lady crabs.	Squids.
1902.								
July 16	Bay traps...	1	.....	1 (little)	.....	1 (much)	.....	.....
18	Katama bay	2	.....	.....	.....	.....	.....	.....
21	Bay traps...	3	.....	.....	.....	2 (much)	.....	.....
23	.....do	2	.....	.....	.....	2 (much)	.....	1 (little)
28	.....do	1	.....	1 (little)	.....	1 (much)	.....	.....
Aug. 21	.....do	2	.....	1 (3)	1 (little)	2 (2)	1 (1)	.....
23	Katama bay	4	3 (5)	2 (5)	.....	.....	1 (2)	.....
1903.								
June 30	Bay traps...	5	.....	2 (little)	.....	4 (much)	.....	.....
July 1	.....do	1	.....	1 (little)	1 (mod.)	1 (mod.)	.....	.....
2	.....do	3	.....	.....	3 (3)	.....	.....	.....
13	.....do	7	1 (2)	.....	2 (much)	6 (much)	.....	.....
19	.....do	8	1 (1)	3 (3)	4 (much)	1 (little)	.....	.....
20	.....do	6	3 (3)	2 (2)	1 (little)	.....	.....	1 (1)
21	.....do	18	3 (5)	2 (much)	.....	1 (much)	.....	.....
24	Wareham ..	3	2 (5)	1 (little)	.....	.....	.....	.....
25	Bay traps...	14	6 (much)	1 (little)	3 (much)	.....	.....	3 (much)
29	.....do	15	9 (9)	3 (much)	3 (mod.)	5 (mod.)	2 (2)	4 (much)
31	.....do	6	5 (10)	1 (1)	2 (little)	.....	1 (1)	.....
Aug. 4	.....do	3	2 (much)	.....	.....	.....	.....	1 (mod.)
6	.....do	20	9 (20)	6 (8)	5 (much)	2 (little)	3 (3)	2 (4)
7	.....do	7	4 (6)	2 (2)	.....	.....	.....	1 (1)
10	.....do	5	1 (1)	1 (2)	1 (1)	.....	.....	.....
11	.....do	23	8 (9)	.....	1 (1)	2 (little)	1 (1)	3 (mod.)
15	.....do	3	1 (1)	1 (1)	.....	.....	1 (1)	.....
17	.....do	11	3 (4)	1 (1)	2 (2)	1 (mod.)	2 (little)	2 (3)
18	.....do	5	3 (3)	1 (1)	1 (1)	.....	.....	2 (2)
24	.....do	41	12 (12)	10 (12)	4 (much)	5 (5)	.....	1 (1)
26	.....do	14	3 (3)	3 (6)	.....	.....	3 (3)	1 (1)
28	.....do	10	1 (1)	2 (3)	3 (3)	.....	.....	.....
1904.								
July 2	Bay traps...	7	3 (6)	1 (little)	3 (3)	2 (2)	.....	.....
5	.....do	1	.....	.....	.....	.....	1 (1)	.....
6	.....do	17	3 (3)	3 (6)	3 (3)	.....	9 (11)	2 (little)
7	.....do	7	2 (3)	1 (1)	2 (little)	.....	2 (2)	.....
9	.....do	13	7 (13)	1 (2)	.....	.....	4 (4)	5 (6)
11	.....do	3	3 (4)	.....	1 (little)	1 (1)	.....	1 (1)
16	.....do	5	2 (2)	1 (1)	1 (1)	.....	2 (3)	1 (little)
18	.....do	5	3 (5)	.....	.....	.....	1 (little)	1 (little)
19	.....do	3	1 (3)	.....	1 (little)	.....	.....	.....
20	.....do	1	1 (1)	.....	.....	.....	.....	.....
23	.....do	2	.....	.....	2 (3)	.....	.....	.....
25	.....do	3	1 (2)	2 (2)	.....	.....	1 (1)	.....
29	Bay trawl ..	4	4 (5)	1 (1)	.....	.....	.....	.....
Aug. 1	Bay traps...	2	2 (4)	1 (3)	.....	.....	.....	.....
3	.....do	3	1 (4)	2 (4)	.....	.....	1 (1)	.....
4	.....do	17	5 (5)	4 (4)	3 (much)	.....	1 (1)	1 (little)
5	.....do	3	.....	2 (2)	1 (1)	.....	.....	.....
9	.....do	8	3 (5)	1 (2)	2 (2)	.....	.....	.....
10	.....do	2	1 (1)	.....	.....	.....	.....	.....
11	.....do	5	3 (4)	2 (2)	.....	.....	1 (1)	.....
13	.....do	2	1 (1)	.....	1 (little)	.....	1 (1)	.....
16	.....do	6	2 (mod.)	1 (2)	1 (1)	.....	.....	1 (1)
17	.....do	6	3 (4)	1 (1)	2 (little)	.....	.....	.....
19	.....do	4	3 (much)	2 (2)	.....	1 (1)	.....	2 (mod.)
20	.....do	2	1 (3)	.....	.....	1 (1)	.....	.....
24	.....do	1	.....	.....	1 (little)	.....	.....	.....
25	.....do	5	.....	1 (2)	.....	3 (mod.)	.....	.....
30	.....do	8	.....	3 (3)	1 (1)	.....	.....	.....
	Total[a]...	388	135 (169+)	78 (90+)	62 (26+)	44 (12+)	39 (41+)	36 (21+)
	Per cent.....		34.77	20.1	15.99	11.31	10.05	9.27

[a] The importance of the "plus" in the totals of food (the figures in parentheses) must not be overlooked. In many cases the quantities not reckoned in figures were consider-

THE SMOOTH DOGFISH EXAMINED.

of given species eaten is included within parenthesis. (mod. = moderate.)

Number of stomachs containing—								
Nereis.	Eel-grass.	Hermit crabs.	Razor clams.	Gebia.	Fish, species undetermined.	Other matter undet.	Nothing.	Miscellaneous.
					2 (mod.)			2 (3 prawns).
							1	
						1		
1 (3)							1	1 sculpin, 1 silverside, 1 *Mytilus*.
1 (little)								2 (3 puffers), 1 pebble.
								1 scup.
								Caudal 1/3 of a bonito.
1 (2)								
1 (1)	2 (little)					1	10	4 pocket crabs.
				2 (2)				
	1 (little)			1 (1)	2 (little)	1		
	1 (little)							1 scup, 1 *Solenomya* velum, jaw of a squetengue.
2 (3)						1		1 *Phascaloscoma*, 1 stickleback.
					1 (little)			1 lamellibranch.
7 (12)	5 (much)			1 (1)		2		1 *Callianassa*, 944 *Callianassa* eggs(?).
								Tubularia couthouyi.
1 (3)					1 (little)	2		1 lamellibranch.
4 (6)	2 (much)	3 (3)		1 (1)		2	6	
2 (3)		1 (1)	1 (1)			1		1 red grape, knot of weed, 4 annelids.
		1 (1)	1 (1)		1 (little)			
			2 (2)		1 (little)			
2 (2)	6 (much)	2 (little)	1 (little)		3 (mod.)		12	
			2 (mod.)				6	
							4	
	1 (little)							
1 (1)	2 (little)	2 (3)	3 (5)					2 amphipods.
							2	2 pebbles covered with algæ and hydroids.
			1 (1)					3 snail shells.
					2 (little)			
		1 (1)			1 (1)			
		1 (1)						
			1 (1)					
			1 (1)					
1 (2)		1 (1)	1 (1)					Several pieces of carrot and potato.
1 (little)	1 (little)				1 (little)		2	
	1 (little)							
			1 (1)		2 (little)		2	
		1 (1)						
1 (1)	1 (little)		1 (1)					
1 (2)								
	1 (little)						1	
		1 (1)						
		1 (1)			1 (much)			
		1 (little)						
	2 (little)	1 (1)						
1 (1)								
28 (40+)	26	17 (15+)	16 (15+)	5 (5)	18 (1+)	11	47	
7.21	6.70	4.38	4.12	1.28	4.63	2.83	12.11	

able, and their sum, represented by the "plus," is no insignificant factor in the total, although it can not be adequately expressed.

ESTIMATE OF DESTRUCTIVENESS.

The significance of the foregoing results is made apparent upon the reduction to figures of the damage resulting to the lobster fisheries from the presence of 100,000 smooth dogfish in a locality like Buzzards Bay during a single season. It is, of course, impossible to make even an approximate estimate of the number of any kind of fish that are present in a given area of considerable extent. But judging from the great numbers that are taken in the traps and from the fact that smooth dogfish can be caught in almost any part of Buzzards Bay where a baited hook is let down, it may be assumed that the number of smooth dogfish in that region is not less than 100,000, and this, to my mind, is a very conservative estimate. By a series of experiments it was found that a smooth dogfish can completely digest and pass off from the stomach a rock crab or lobster in from 65 to 84 hours. Several medium-sized smooth dogfish were kept in a large cod car for five days to make sure that their alimentary tracts were clean. Rock crabs and large pieces of lobster were then forced down their throats, and at intervals of from 12 to 20 hours fish were caught and killed and the digestive tract contents examined. After about 65 hours the shells of crabs or lobsters were soft and flaky and could be mashed and molded by the fingers. After about 84 hours, or half a week, nearly all traces of the stomach contents had passed into the intestine. Judging from these facts, in order for 16 per cent of the smooth dogfish constantly to contain lobster material, that number would have to take, on the average, a lobster twice each week. Sixteen per cent of $100{,}000 \times 2 = 32{,}000$, which would represent the number of lobsters per week consumed by 100,000 smooth dogfish. Since these fish are common in Buzzards Bay for not less than twenty weeks of each year, we would then have $20 \times 32{,}000 = 640{,}000$, the minimum number of lobsters probably destroyed in Buzzards Bay during one season by this agency.

From data collected, and by this same method of calculation, there is obtained for the principal species eaten the following estimate of the number of individuals of each destroyed each year in the region of Buzzards Bay by every 100,000 smooth dogfish:

ESTIMATE OF FISH DESTROYED EACH YEAR BY EVERY 100,000 DOGFISH IN BUZZARDS BAY.

Species.	Number destroyed.	Species.	Number destroyed.
Rock crab (*Cancer irroratus*)	1,390,800	Puffer (*Spheroides maculatus*)	20,000
Spider crab (*Libinia canaliculata*)	804,000	Scup (*Stenotomus chrysops*)	20,000
Lobster (*Homarus americanus*)	639,600	Gasteropod (*Lacuna vincta*)	20,000
Menhaden (*Brevoortia tyrannus*)	452,400	Sculpin (*Myoxocephalus æneus*)	10,000
Lady crab (*Platyonichus ocellatus*)	402,000	Silverside (*Menidia notata*)	10,000
Squid (*Loligo pealii*)	370,800	Sea mussel (*Mytilus edulis*)	10,000
Nereis (*virens* or *limbata*)	288,400	Bonito (*Sarda sarda*)	10,000
Eelgrass (*Zostera marina*); comparatively little.		*Solenomya velum*	10,000
		Squeteague (*Cynoscion regalis*)	10,000
Fish (species undetermined)	183,200	*Phascalosoma*	10,000
Hermit crab (*Eupagurus politicaris*)	173,200	Stickleback (*Gasterosteus bispinosus*)	10,000
Razor clam (*Ensatella americana*)	164,800	*Callianassa*	10,000
Gebia affinis	49,600	Amphipods	10,000
Pocket crab (*Panopeus*)	20,000		
Prawn (*Palæmonetes*)	20,000	Total	5,120,800

FEEDING HABITS.

The unnatural conditions surrounding the fishes in the traps involve the above results in a considerable degree of error. For more nearly accurate calculation it is necessary to consider, in addition to the above factors, what the dogfish had met with during its short experience in captivity and also what is its normal habit of feeding. In the traps it was generally crowded into close quarters with menhaden, squids, puffers, scups, bonitos, squeteagues, and other fishes. Any food taken in the trap had to come from this list, and that food was taken in the trap is very evident upon a glance at the above table. On the other hand, the crustaceans (except the spider crab) and the molluscs were rarely, if ever, taken in the traps, so that such of these as were found in the dogfish were most likely taken in their natural haunts.

The study of a number of live dogfish kept in the shark pool of the Woods Hole station shed considerable light on their habits of feeding. This pool is about 100 feet long by 25 feet wide, with a depth of the water varying from about 4 to 7½ feet, according to the tide. Except when the tide was quite high, it was an easy matter to see the bottom and the fishes swimming about.

The usual habit of the dogfishes was to swim close to the bottom, searching for food over every square inch of the ground. If a rock crab or spider crab were thrown into the pool, they soon found it. They would turn over on their sides to seize it, and then dart rapidly off, shaking it much as a terrier would shake a rat. After swallowing the crab, the dogfish kept up its active swimming, often returning to the place where the food had been found, just as if hoping more might be discovered there. The experiment of throwing in food was repeated several times, always with the same result. A tame loon, which was kept in the pool for a week or two, was often

bothered by the dogfishes coming up and seizing it by the legs, but no harm came to the loon from this experience.

Besides the few sharks, skates, and cunners, there were put into the pool a number of menhaden which had been inoculated with a germ known to cause a disease in this fish. It was noticed that as long as the menhaden remained normally active they were not molested by the dogfish, but as soon as one began to show signs of the disease by turning on its side and swimming in circles, it was attacked and eaten by the dogfish.

It is pretty safe to conclude, therefore, that the smooth dogfish is normally a bottom feeder and does not prey upon active fishes like bonito, menhaden, scup, etc., unless in close quarters with them or unless it encounters them in a weakened, helpless condition. It feeds primarily upon crustaceans, chief among which are the rock crab, spider crab, and the lobster. To diminish by 95 per cent the number of teleost fishes given in the foregoing list as destroyed by every 100,000 smooth dogfish would be much more nearly to approximate the actual truth. The number of crustaceans consumed is probably much greater than the estimate.

THE SAND SHARK.

GENERAL CHARACTERS.

The sand shark (*Carcharias littoralis*) has an elongate body, which, however, is much heavier than that of the smooth dogfish; the head is rather pointed, mouth ventral, and jaws set with long, very sharp teeth; skin covered with sharp tubercles, which are larger and far less numerous than those of the smooth dogfish. The sand shark is of a gray color and measures from 4 to 6 feet in length. According to Jordan and Evermann it is "rather common on our Atlantic coast, especially between Cape Cod and Cape Hatteras."

FOOD.

But two references to the food of the sand shark have been found. Verrill and Smith (1873) say:

> Many specimens taken at Woods Hole in July and August contained lobsters (*Homarus americanus*) in abundance, *Cancer irroratus*, and squids (*Loligo pealii*).

Linton (1901) reports:

> Fish (menhaden, sea bass, scup, and butterfish noted) and squid.

EXAMINATION OF DIGESTIVE TRACTS.

During July and August, 1904, 66 sand sharks were examined for the purpose of determining their food. The results are given in the accompanying table.

Statement of the Food of the Sand Sharks Examined.

Note.—Figure outside of parenthesis denotes number of sand sharks; number or amount of given species eaten is included within parenthesis.

Date.	Locality.	Specimens examined.	Number of stomachs containing—									
			Menhaden.	Alewives.	Flounders.	Scups.	Butterfish.	Eelgrass.	Bonitos.	Fish, species undetermined.	Nothing.	Miscellaneous.
1904.												
July 5	Bay trap	2	1 (1)								1	
6	do	5	4 (5)	1 (1)	2 (2)			1 (little)		1 (little)		
7	do	5	1 (1)								4	
8	do	5									5	
9	do	6	2 (3)	1 (1)			1 (1)			1 (1)	2	
11	do	3	2 (3)	1 (1)		1 (1)		1 (little)				1 squid
19	do	2				1 (1)						
20	do	3	3 (4)									
29	do	1	1 (1)									
Aug. 4	do	2	2 (2)									
8	do	2	1 (2)				1 (2)					1 squeteague; 1 sea robin.
9	do	2	1 (1)	1 (1)	1 (1)			1 (little)				
10	do	2	2 (2)									
11	Sound trap	11		1 (2)		1 (1)				9 (mod.)		
13	Bay trap	1					1 (1)					
16	Sound trap	3	1 (1)		1 (1)				2(6 young)			
17	Bay trap	2									2	
18	do	2	2 (4)									
23	do	2	2 (4)									
26	do	2	2 (4)									
30	do	3								3 (little)		
	Total[a]	66	27 (38)	5 (6)	4 (4)	3 (3)	3 (3)	3 (little)	2(6 young)	11 (1+)	14	
	Per cent		40.9	7.57	6.06	4.54	4.54	4.54	3.03	21.21	21.21	

[a] See note on page 12.

ESTIMATE OF DESTRUCTIVENESS.

The foregoing figures show that the food of the sand shark consists almost entirely of fish. No lobster, crab, or other crustacean was found in any of the stomachs, which fact is at variance with the report of Verrill and Smith, who state that the sand shark feeds extensively on these forms. My observations accord more closely with Dr. Linton's. It should be taken into account, however, that the sharks examined were taken from unnatural surroundings, namely, the traps, where they were held in close quarters with most of the species of fish found within them. But, taking the data as collected, and estimating the number of sand sharks in the vicinity where these were taken (Buzzards Bay and Vineyard Sound) at only 25,000, and allowing to each sand shark four fish per week, a most conservative estimate, the numbers eaten by sand sharks in one month would be as follows:

ESTIMATE OF FISH DESTROYED EACH MONTH BY 25,000 SAND SHARKS IN BUZZARDS BAY AND VINEYARD SOUND.

Species.	Number destroyed.	Species.	Number destroyed.
Menhaden (*Brevoortia tyrannus*)	167,600	Butterfish (*Poronotus triacanthus*)	18,160
Alewife (*Pomolobus pseudoharengus*)	30,280	Bonito (*Sarda sarda*)	12,120
Flounder (*Paralichthys dentatus*)	24,240		
Scup (*Stenotomus chrysops*)	18,160	Total	270,560

The sand shark is to be characterized as a fish which is destructive to fishes of food or other commercial value, although not nearly so destructive as the horned dogfish, which will be considered next.

THE HORNED DOGFISH.

GENERAL APPEARANCE AND HABITS.

In general appearance the horned dogfish (*Squalus acanthias*) very much resembles the smooth dogfish. It has the same slender, elongate body covered with numerous sharp tubercles (placoid scales), the ventrally placed mouth and nostrils, and the characteristic spiracles. The color is slaty above, with a line of whitish spots extending along either side of the back. The under portions fade out almost to white. The horned dogfish is to be distinguished from the smooth dogfish by its small sharp teeth and a rather high dorsal spine in front of each of the two dorsal fins. In length the adults vary from 2 to 3 feet and in weight from 5 to 15 pounds. They are strong, active swimmers, and roam about the shoals and deeper waters in great schools, pursuing their prey like a pack of wolves. The name

dogfish has probably been applied because of this character, and is given to numerous other shark-like fishes having this same habit. Like the smooth dogfish, the young of the horned dogfish are carried by the parent, and when born are similar to the adults and ready to enter into vigorous activities. This species is represented in figure 2, plate 1.

DISTRIBUTION AND ABUNDANCE.

The range of the horned dogfish is wide. During the summer and fall months it is abundant along the Atlantic coast from Newfoundland to Cape Cod, and during the winter occurs as far south as Cuba. This same species is also found along the European shores, where it is known by various names, such as "picked dog," "horned dog," "spur dog," "skittle dog," and "hoe."

A comparison of successive years with reference to the periods of abundance of this species along the coast shows that the horned dogfish remain longer now than formerly and furthermore are making their way into hitherto unfrequented regions. Captain Atwood writes that when he first went fishing, in 1810 to 1820, they appeared in the spring and were abundant for a day or two, after which they disappeared. Not one would be seen all summer, but they would return again about the middle of September and stay into November. During the early sixties they were present all summer. Storer (1867) says that they appeared in the spring and autumn and frequently occurred in immense numbers in shallow water or near the shore, but rarely remaining for more than three or four days. He speaks of having seen a few thrown out from the nets at Provincetown as late as June 27, 1847. He further says that they return again in September to remain until the middle of November. Goode (1884) speaks of their appearing at Provincetown, Mass., a little while after the mackerel and disappearing a short time before them. Smith (1898) in his paper entitled "The Fishes Found in the Vicinity of Woods Hole," says of dogfish:

> Less abundant than formerly and comparatively scarce in 1897. When the fish factory was established at Woods Hole this was the principal fish utilized in the manufacture of oil and guano; later the scarcity or irregularity of the supply necessitated the use of menhaden.

The Report of the Commissioner of Fisheries for 1903 says:

> Dogfish appeared on the coast in and near Penobscot Bay in unwonted numbers in 1902, and committed great havoc among the deep-water fishes. They appeared earlier than usual, being found near Monhegan Island as early as the middle of May and becoming quite plentiful all along the coast in June, but August appears to have been, as usual, the month of greatest abundance.

Capt. B. R. Kelley, in his letter published at the end of this chapter, writes that they appeared at Provincetown on July 14, 1904 (which

was about fifteen days later than in the previous year), and were never before so plentiful. They remain all summer and leave about the last of November. Mr. H. E. Duff, of Petit de Grat, Cape Breton, Canada, writes that in that region—

> They appear in small numbers about the middle of July, getting more plentiful later on, say September, October, and November. They disappear say December, as we get them at times when winter fishing is going on. They are here at the time of our mackerel fishing, summer and fall. There is no fishing for dogfish for any purpose—only fishermen growling and swearing at the dogfish.

FEEDING HABITS.

Storer, in his History of the Fishes of Massachusetts (1867), states that the food of the horned dogfish is "mackerel and other fishes and offal and garbage thrown upon the bottoms by the fishermen." Goode (1887) says that it preys upon cod. Cunningham (1896) says it preys upon such small bony fishes as herring and pilchard. Smith (1898) says: "When the horned dogfish first comes in May, it feeds largely on ctenophores." Linton (1901) found bits of eel grass and the test of a young sea urchin in one specimen, and states that Mr. C. F. Silvester reports having found fish of various kinds in the stomachs of dogfish from Provincetown.

Biologists, however, have given comparatively little space to this subject. The character of the food of this dogfish is best known through the observations and experiences of the fishermen. Wolf-like in their habits, roving in great schools, constantly in search of prey, these fish have wrought such havoc to the mackerel, herring, cod, haddock, and other fisheries all along the coast that there is no question in any fisherman's mind as to what the horned dogfish eats. In the Fish Commission Bulletin for 1884 Captain Collins tells of a great school of dogfish which, completely surrounding a school of mackerel, closed in on all sides and from underneath and devoured almost the entire school. According to Captain Collins, a similar performance was twice witnessed off Wood Island by Capt. Joseph Smith, of Gloucester. The Report of the Commissioner of Fisheries for 1903 tells how a fleet of fishing boats about Mount Desert Rock was driven from the fishing grounds by horned dogfish early in July and could not return again until well into September. The dogfish took both the bait and the trawls and attacked the fish that had been caught, which in this case were principally haddock and hake. All that the fishermen could get were heads of haddock and hake and a great many worse than worthless dogfish.

While at Provincetown, August 20, 1903, I had opportunity to make some observation of the abundance and voracious habits of this fish. Captain Kelley took a fishing party out in his sloop to a point in the harbor about 500 feet from the shore, where stands the harbor

light-house. During the first fifteen or twenty minutes several hake and two large pollock were caught. Then the dogfish began to appear in great numbers. While one man was trying to land a hake it was attacked by half a dozen dogfish, which followed it clear to the surface, biting and tearing it so that all the luckless fisherman got for his share of the catch was the head, and a portion of the spinal column with a few bits of flesh clinging to it. This experience is one common to all the ground fishermen of that region. Soon all that we could catch were dogfish. In less than two hours' time 78 were landed, which was about as fast as our lines could be baited, thrown overboard, pulled up, and the dogfish taken off; it usually took longer to get the fish off the hook than to get them on it. They grew more and more plentiful as the fishing went on. Often they were seen swimming about the boat close to the surface of the water, but only for a short time, when they would dart downward out of sight. Captain Kelly and other fishermen said that outside the harbor they were larger and much more abundant.

VARIETY OF FOOD.

A statistical study of the food of the horned dogfish, as of the other species dealt with in this paper, was not possible in these investigations, owing to the scarcity of specimens obtainable during July and August in the vicinity of Woods Hole, where the work was conducted. The variety of food taken by the dogfish, however, is well shown in the following instances: Of some 90 specimens taken at Provincetown August 20 and 21, 1903, 31 contained the little jellyfish *Cydippe*, about 75 to each dogfish; 11 specimens contained squid (*Ommastrephes*), which were probably stolen bait; 3 contained the remains of 4 small crustaceans; 2 contained annelids; 1 contained a hake; 1 an insect; 1 an isopod; 47 were empty. Three dogfish taken in a trap at Nomans Land August 2, 1904, contained 1 a *Nereis*, 1 a squid, and 2 contained fish too far digested to be identified. Of 20 or 30 specimens from Gloucester, received at the Harvard Zoological Laboratory during the past two years, all whose stomachs were not empty contained fish. The fish were too far digested to be identified in most cases, but the greater part recognizable were herring.

The recent report of the Massachusetts Board of Fish Commissioners upon the damage done by dogfish in 1905 records the food of 674 dogfish whose stomachs were examined. Fish, apparently marketable species, were found in most instances. A few of the dogfish had eaten ctenophores.

DESTRUCTIVENESS.

This evil has become greater in the last few years, and the fishermen state that it is now the most serious they have to contend with. The dogfish in countless numbers overwhelm the nets, mutilating and

devouring the gilled fishes, thus depriving the fishermen of the fruits of their labor; and they become themselves entangled in the net, which they bite with their sharp teeth and tear in their writhings until it is beyond repair. They drive away or destroy the great schools of squid, upon which the fishermen depend for bait, and they even crowd into lobster pots. The following letter from Capt. B. R. Kelley, of Provincetown, Mass., represents the feelings of the fishermen upon the subject of the horned dogfish:

Your letter of inquiry about dogfish at hand, which I am pleased to answer. I will answer your inquiries in order as you asked them.

First. There is no one in Provincetown who is using the dogfish for any profit.

Second. There is no commercial use being made of the dogfish either for oil, skins, glue, fertilizer, or food.

Third. The dogfish never were so plentiful as they are this year. They came about fifteen days later than last year, making their appearance in large quantities July 14, and were very large in size. July 25 small ones came in large quantities, and they ate our nets up so badly we had to stop fishing for mackerel, and unless some method for destroying the dogfish can be found mackerel will cost the consumer more than 30 cents and cod and haddock more than 12 cents per pound. We have had to take our nets out and dry them and put them away for the season, and now our boats lay in the harbor, practically of no use to us until the dogfish thin out. As for ground fishing, it is impossible to keep a hook on the bottom. Some of our large vessels have lost hundreds of dollars' worth of trawls. I have heard some of our fishermen say that if something is not done to exterminate the dogfish they will have to give up fishing in the south channel, or, in other words, the southeast part of Georges Banks. I will describe to you just how plentiful the dogfish were. Southeast from Nomans Land in June last we dared not put our nets in the water at night unless it looked as if the weather was going to be very fine through the night, because if there came up a blow in the night and we could not get our nets they would fill up with dogfish before morning and we would lose them. I wish you could see some of our nets that were eaten by the dogfish. I know of no fish that can do so much damage in the same time as the dogfish can. There have been not hundreds, but thousands, of dollars' worth of gill nets destroyed by these dogfish. We can not keep any bait in our lobster pots. Some of the lobster fishermen tell me the pots have from one to five dogfish in them some mornings. Our harbor and bay are full of them.

Some of our fishermen in years gone by have been in the habit of catching bass on the back side of Cape Cod by throwing a line from the shore, but the last two years they can not keep a hook in the water two minutes before a dogfish will have the bait. These fish are of the largest kind.

You wanted to know about what time these fish leave our coast. Probably that varies, as they do coming on the coast. Last year the body of the fish left the last of November. Our fishermen were doing a good business catching mackerel in our bay, but there have not been any seen since the appearance of the dogfish from Cape Cod to Eastport, Me., and our fishermen have come to the conclusion, whether their idea is right or wrong, that the dogfish have eaten up all of the live bait that the mackerel feed on. Now, Mr. Field, if something is not done to exterminate the dogfish the consumers will have to pay more than

25 cents for a mackerel and more than 10 or 12 cents for a pound of cod or haddock.

If Massachusetts would pay as much to exterminate these dogfish as they do to exterminate the brown-tail moth, I think the money would be spent for a much better purpose. I think I have not exaggerated one word in this letter in regard to the damage this fish is doing to the community. I think there is no pencil can give him his due. He is not even fit to make guano of.

The facts show that the horned dogfish is not hated without due cause. Not only does it devour and drive away valuable food fishes and bait, but it robs and injures or destroys the nets, seines, trawls, and other fishing gear to such an extent that the fishermen all along the coast from Cape Cod to Newfoundland are crying for means to rid them of this "pest." Canada has decided upon a plan of action, and measures are under consideration elsewhere. These will be discussed in a later chapter of this report.

THE SUMMER SKATE.

CHARACTERS OF THE FISH.

The summer skate (*Raja erinacea*) has a broad, flat body, rhomboidal in outline, from which extends a rather long tail. The upper parts are variously armed with sharp spines. The color is a light brown above, with small round spots of dark brown; the under parts are white. The mouth, with its much-curved jaws, is small and ventral in position. The teeth are small, and all are blunt in the females, though in the males the middle ones are sharp. They are adapted, as in the smooth dogfish, for crushing rather than for seizing and holding prey. The nostrils open on the ventral side of the head in front of the mouth, with the corners of which they are connected by a groove. Five pairs of gill slits are visible behind the mouth. Two apertures, the spiracles, open dorsally, one behind each eye. The broad flaps on the sides of the body constitute the pectoral fins. The posterior or pelvic pair of fins lie ventrally on either side of the cloacal opening. In the males the inner sides of these fins are modified into stiff rods, called claspers, which together serve as an organ of copulation. In length the summer skate measures from 1 to 2 feet, the females being larger than the males. This fish, because of its flat body, ventral mouth, spiracles through which water may be inspired from above, dorsally placed eyes, and the whole upper surface pebbly in appearance, is admirably adapted to live on the bottom of the ocean. It is abundant on the Atlantic coast from Maine to Virginia, and is known to the fishermen by the names "bonnet" and "tobacco box."

REPRODUCTION.

Reproduction in the skate is accomplished by means of eggs deposited singly, each inclosed within a thin, tough, horny case, which may be described as pillow-shaped, with a long tapering tube projecting from each of the four angles. The empty cases are often found cast up along the shore and are popularly known as "mermaid's purses." Fertilization is internal, as in the dogfish. As soon as an egg is impregnated it becomes surrounded by a layer of gelatinous albumen and inclosed in the chitinous shell, which is secreted by a shell gland. The egg is then laid by the mother in some favorable place, and within the shell envelope the young skate develops, well protected. When fully formed, it escapes by rupturing the case. In spring, summer, and fall a single female skate may deposit a great number of eggs, the production being continued during this period.

USES.

On our Atlantic coast it may be said that skates in general are little used as food. In other parts of the globe, however, they have no little recognition. To quote Yarrell (1836):

> The skate as food are held in very different degrees of estimation in different places. In London particularly large quantities are consumed, and the flesh is considered delicate and well flavored; but on some parts of the coast, though caught in considerable numbers both by lines and nets, the flesh is seldom devoted to any purpose beyond that of baiting pots for catching crabs and lobsters.
>
> Skate are in best condition for the table during autumn and winter. In spring and early part of summer they are usually maturing eggs or young, and their flesh is then soft and woolly.

Gunther (1880) says of the skates that "all are eatable, and some of them are brought to market."

Four years later Goode wrote:

> They are all troublesome to the fisherman, clogging his lines and pound nets; but none of them are of the slightest economical value, except the so-called "barn-door skate" (*Raia lævis*), which is occasionally salted for use by the fishermen of Portsmouth, N. H., and which has in the last two or three years attracted some notice in New York. Miss Corson, in her cooking school, has called attention to its excellent qualities as a food fish, and skates may be found on the bill of fare at certain restaurants * * * Only the "wings" or the fleshy flaps to the pectoral fins are used.

The most recent mention of skates as food is by Jordan (1905), who says:

> Most of the species belong to the typical genus *Raja*, and these are especially numerous on the coast of all northern regions, where they are largely used as food. The flesh, although rather coarse and not well flavored, can be improved by hot butter, and as "raie au beurre noir" is appreciated by the epicure.

In San Francisco the French and Italians are said to buy skates, which they relish as a food. The trade, however, is very small.

At Chilmark, Marthas Vineyard, during these observations, the only purpose for which skates were seen to be used by the fishermen was as bait for lobster and eel pots. Skates have, however, been used as fertilizer. Goode (1887) reports having seen them at factories put in the boilers with certain other fishes. An article in the Yarmouth Register for June, 1870, states that Mr. Wilson Reyder, of Barnstable, used many cartloads of skates for manure; and that Enoch F. Reyder found it remunerative to boil them down and convert them into guano, after oil had been extracted from the livers. Skates are not utilized extensively in this country, however. Moreover, little seems to be known about their general habits and economic relations.

FOOD.

A general account in the Standard Natural History, vol. III, states the food of the skate to be shellfish, crabs, flounders, and other bottom frequenting forms. To capture the prey "the ray swims rapidly over a fish, and then settles down upon it, holding it from escape with its broad body; then by suitable muscles, the jaws are protruded beyond the rest of the surface and the object is taken in."

The best food record of the species is contributed by Linton (1901), and reads thus:

> Usually crustacea and annelids, but bivalve mollusks, squid, and fish are also frequently found in the stomach. In the summer of 1899 thirty-two skates were examined and the following food material noted: Crabs (hermit, *Cancer*, *Callinectes*, *Panopeus*, and others), shrimps, amphipods, annelids, squid, bivalve mollusks, small fish.

EXAMINATION OF DIGESTIVE TRACTS.

My own results, obtained from the examination of the alimentary tracts of 516 summer skates, and briefly shown in the accompanying table, are thoroughly in accord with the foregoing statements. More than 29 per cent of the 516 skates contained crabs (*Cancer*, *Ovalipes*, *Panopeus*, and *Pagurus*), most of which were the common rock crab (*Cancer irroratus*). The shrimp (*Crago septemspinosus*) is also devoured in great numbers, nearly 15 per cent of the skates containing it in larger or smaller quantities; and a few specimens contained amphipods in considerable numbers, making the total number of skates which had eaten crustacea very large.

Statement of the Food of the Skates Examined.

Note.—Figures outside of parenthesis denote number of skates; numbers or amounts of given species eaten are included within parenthesis.

Date.	Locality.	Specimens examined.	Number of stomachs containing—									Miscellaneous food.
			Crabs.	Shrimps.	Small fishes.	Squids.	Nereis.	Razor clams.	Amphipods.	Nothing.	Matter undetermined.	
1905.												
July 7	Buzzards Bay	2	2 (4)	.....	2 (2)	.....	.....	.....	.....	.....	.....	Little eel grass.
8	.....do	2	1 (4)	1 (2)	1 (1)	.....	.....	1 (3)	.....	.....	.....	1 pebble.
17	Menemsha Bight.	26	8 (much)	.....	1 (little)	.....	2 (2)	3 (mod.)	.....	4	9	Knot of eel grass; 1 pebble.
18	.....do	31	11 (much)	1 (1)	9 (much)	.....	2 (2)	.....	.....	5	4	Fragments of lobster.
19	.....do	20	4 (4)	6 (12)	3 (little)	2 (much)	.....	1 (little)	.....	2	5	
22	.....do	30	8 (much)	5 (6)	6 (much)	3 (mod.)	2 (2)	.....	.....	6	7	
27	.....do	6	1 (2)	2 (3)	.....	.....	2 (2)	.....	2 (73)	3	.....	
28	.....do	8	6 (9)	1 (2)	.....	.....	1 (1)	.....	3 (43)	1	.....	
31	.....do	24	8 (8)	3 (10—)	2 (much)	.....	2 (2)	4 (4)	.....	7	.....	Do.
Aug. 3	.....do	14	5 (8)	3 (10—)	1 (little)	.....	1 (1)	2 (2)	1 (1)	4	1	
8	.....do	55	14 (18)	4 (5)	16 (73)	1 (1)	1 (1)	4 (mod.)	.....	21	3	
9	.....do	26	7 (9)	6 (14)	2 (little)	1 (1)	2 (2)	.....	.....	13	1	
10	.....do	2	1 (2)	.....	.....	.....	.....	.....	.....	1	.....	
11	.....do	56	17 (24)	2 (2)	4 (much)	.....	.....	2 (2)	2 (much)	32	2	
12	.....do	4	1 (1)	.....	.....	.....	.....	.....	.....	3	.....	
17	.....do	14	2 (3)	.....	.....	.....	3 (4)	.....	2 (8)	2	8	
18	.....do	50	7 (7)	3 (much)	1 (1)	3 (3—)	1 (1)	.....	1 (1)	11	22	Little alga.
19	.....do	10	2 (4)	2 (3)	.....	2 (2)	2 (2)	.....	2 (much)	2	3	
21	.....do	57	15 (33)	14 (25)	17 (much)	12 (14)	6 (6)	1 (1)	2 (much)	1	12	Do.
22	.....do	24	8 (19)	9 (34)	1 (little)	2 (2)	1 (1)	1 (1)	.....	6	6	
23	.....do	34	15 (34)	9 (25)	1 (little)	5 (little)	2 (3)	.....	3 (11)	5	8	
24	.....do	21	11 (19)	5 (14)	1 (1)	2 (little)	2 (2)	.....	.....	4	3	Do.
	Total[a] ..	516	154 (212+)	76 (168+)	68 (78+)	33 (23+)	32 (34)	19 (13+)	18 (137+)	133	95	
	Per cent		29.06+	14.72+	13.17+	6.39+	6.20+	3.68	3.48	25.93	18.41	

[a] See note on page 12.

Small fishes (*Ammodytes*, *Pomolobus*, *Paralichthys*), but for the most part the sand eel (*Ammodytes americanus*), had been consumed by some in large numbers, and no doubt form a considerable part of the skate's food supply. Many of the small fishes it was impossible to identify on account of the advanced stage of digestion.

It was surprising to find squid (*Loligo pealii*), which is a very active swimmer, in as many as 6 per cent of these sluggish fishes. This was doubtless due to the fact that the skates were taken from the traps, which swarmed with squids to such a degree that it was an easy matter to seize one in such close quarters. Under natural conditions it is most likely that squids are rarely taken.

The sea worm (*Nereis*) appears as a factor in the skate's diet. Over 6 per cent of the specimens examined contained annelids of this genus, which must have been eaten before the fish entered the traps. The razor clam (*Ensatella americana*) was found in over 3 per cent of the number. Other mollusks are probably eaten, although, strange to say, none were found in the above 516 specimens. As many as 26 per cent had empty stomachs, and over 18 per cent contained matter so far digested that it was impossible to determine its nature. Knots of eel grass and algæ were sometimes found, probably consumed accidentally with other food. The stomachs of two skates contained each a good-sized pebble, which no doubt was also swallowed with food. In one stomach was found a small portion of a lobster.

ESTIMATE OF DESTRUCTIVENESS.

Judging from the above data, the summer skate is a harmless species, whose food is confined to the smaller crustacea (crabs, shrimps, and sand fleas), small fishes, sea worms, and small mollusks. The food is, as might have been expected, similar to that of the smooth dogfish (*Mustelus canis*); but on account of its small size the summer skate is not able to commit the same depredations upon the lobster. Doubtless the larger species, like the barn-door skate (*Raja lævis*) and the big skate (*Raja ocellata*), eat lobsters to a great extent. Indeed, fishermen have told me that they have found lobsters in the stomachs of barn-door skates, and there is little doubt that a systematic study of the food of these skates would confirm the statement.

THE COMMON KILLIFISH.

GENERAL APPEARANCE AND DISTRIBUTION.

The common killifish (*Fundulus heteroclitus*) is a small shore fish varying from 3 to 6 inches in length, with a short, deep, thick-set body and a blunt head, flattened from above. The males are of a

greenish color on the back and sides and orange-yellow below, with numerous spots of white or yellow scattered over the body. Jordan and Evermann give the distribution, "Coast of Maine to the Rio Grande, everywhere very common in brackish waters, often burying itself in the mud in shallow lagoons."

FOOD.

Upon this subject Linton (1899) says:

> The following fish from Waquoit Bay were examined in 1899: August 7, twenty-six, alimentary canals filled with green mud, consisting of a variety of vegetable débris, enormous numbers of diatoms and foraminifers in considerable number. August 28, twenty-two, alimentary canals filled with vegetable material (eel grass, etc.). A specimen from Katama Bay, August 28, 1900, had a shrimp and other small crustaceans in the alimentary tract.

EXAMINATION OF DIGESTIVE TRACTS.

The tabulated statement made up from my examination of 134 specimens shows that the killifish consumes an enormous number of diatoms. In many cases the whole alimentary canal was packed full of these organisms, mostly of the genus *Pleurosigma*. Small crustaceans like prawns and sand fleas constitute the principal food of this fish, however. The number it consumes amounts to millions each year. The algæ noted in the stomachs were of the red, brown, and green kinds, and were probably taken in with the small crustaceans which were living upon them, the latter being the food sought by the fish. In these observations the common killifish was not found to prey on any living forms of direct value to man.

Statement of the Food of the Killifish Examined.

Note.—Figure outside parenthesis denotes number of killifish; number or amount of species eaten is included within parenthesis.

Date.	Locality.	Specimens examined.	Number of stomachs containing—												
			Diatoms.	Small crustacea.	Algæ.	Prawns.	Amphipods.	Molgula.	Nereis.	Eel grass.	Fish, species undetermined.	Snails.	Lady crabs.	Soft-shelled clams.	Matter undetermined.
1902.															
July 24	Great Harbor	28	1 (much)	13(much)	3(much)	4 (9)	1 (little)	.....	.....	2 (little)	.....	.....	1 (mod.)	.....	2(much)[a]
28	do	20	.....	14(much)	1(much)	3 (8)	1 (much)	.....	2 (2)	.....	.....	.....	.....	.....	1 (much)
Aug. 7	do	2	1 (much)	1(much)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
11	do	17	4(v.much)	.....	7(much)	2(much)	7 (much)	.....	.....	2 (little)	.....	.....	1 (little)	.....	.....
13	Katama Bay	8	.....	2(much)	2 (mod.)	3(much)	.....	.....	3 (4)	.....	4 (mod.)	.....	.....	.....	.....
18	Great Pond	30	26(v.much)	3(much)	24(much)	.....	1 (little)	2 (5)	1 (1)	2 (little)	2 (mod.)	5 (23)	.....	2 (few y'g)	(*b*)
1903.															
July 3	do	24	16(v.much)	2 (little)	.....	2 (4)	3 (much)	7 (101)	1 (1)	2 (little)	.....	.....	.....	.....	7 (much)
19	Eel Pond	5	1 (little)	5(much)	2(much)	.....	1 (little)	.....	1 (1)	.....	.....	.....	.....	.....	.....
	Total	134	49	40	39	14 (21)+	14	9 (106)	8 (9)	8	6	5 (23)	2	2	10
	Per cent	.....	36.57	29.85	29.1	10.44	10.44	6.71	5.97	5.97	5.97	3.73	1.49	1.49	7.46

[a] These stomachs also contained *Solenomya velum*.

[b] These stomachs also contained many crustacean eggs.

THE CUNNER.

CHARACTERS AND DISTRIBUTION.

The cunner, or chogset, is a small fish varying from 8 to 12 inches in length, with a rather stout body and moderately pointed head. Upon the upper jaw there are five conspicuous canine teeth, and about four on the lower jaw. The color is a brownish-blue shaded with yellowish-brown above and brassy on the sides. There is, however, considerable individual variation in the coloration. The distribution of the species, according to Jordan and Evermann, is "Atlantic coast from Labrador to Sandy Hook." Within this range it abounds about rocks, wharves, and bridges, where large numbers are caught by hook and line or by nets. There are numerous popular names applied to this fish. It is called "cunner" in Maine and Massachusetts. "Chogset" is a name of Indian origin. In New York it is called "burgall," at Provincetown it is "sea-perch," and at Salem "nipper."

USES.

In former years the cunner fried was much esteemed as a fish for the table. Storer tells of immense quantities being brought to market between the middle of June and late October. At Boston, in order to have them alive for market, they were kept in cars with latticed sides, and these cars, 3 feet deep and 12 or 15 feet long, were anchored in deep water where the tide constantly flowed through them, providing a fresh supply of water for the fishes. As many as 5,000 fish were sometimes kept in a single car, and the daily market supply was taken from these, the cars being replenished every week or two, according to the demand. Goode, in 1888, said that the cunner was used as an article of food from Eastport, Me., to Boston, but elsewhere was rarely eaten and often regarded with disgust. He estimated the catch of the Irish market boats for Boston at 300,000 pounds and that of the other towns and states on the New England coast at from 200,000 to 250,000 pounds. For the past ten years the demand for this fish has steadily decreased, and now very few are marketed. The live cars at Boston are no longer known, and what few fish are sold are purchased by the poorer class of people. The price is 10 or 15 cents a dozen.

FOOD.

The food of the cunner includes a wide range of species—in fact, almost anything. Goode (1888) says:

> Their food is very similar to that of the tautog, except that they can not swallow very large shells. They feed also upon dead animal matter and are among the most important scavengers of our harbors.

Linton (1899) describes the cunner's food as "seaweed, hydroid stems, bryozoa, tunicates, annelids, small crustaceans (*Caprella*, shrimps, etc.), univalve mollusks found in the stomach and intestine—in short, just such food as the fish would get by browsing on the material which grows on wharf piles and similar places."

EXAMINATION OF DIGESTIVE TRACTS.

During the summers of 1902 and 1903 the digestive tracts of 306 cunners were examined, with the results shown in the accompanying table:

Statement of the Food of the Cunners Examined.

Note.—Figure outside of parenthesis denotes number of cunners; number or amount of species eaten is included within parenthesis.

Date.	Locality.	Specimens examined.	Number of stomachs containing—										
			Sand fleas.	Eelgrass.	Snails.	Small molluses.	Prawns.	Small crustaceans.	Fish, species undetermined.	Eelgrass seeds.	Botryllus.	Rock crabs.	Algæ.
1902.													
July 3	Eel Pond	8	2 (much)	2 (little)			2 (5)	4 (much)	3 (little)				
4	do	3						2 (much)	2 (little)				1 (little)
11	do	5	5 (much)	3 (little)			1 (little)		5 (little)				
12	Great Harbor	6	2 (much)	1 (mod.)		5 (much)	4 (4)	1 (few)	3 (little)		15 (much)		
12	Eel Pond	25	13 (much)			4 (little)	1 (2)	3 (much)	6 (little)				
16	do	12	12 (v. much)			1 (little)	1 (2)		1 (little)		3 (much)		
18	Katama Bay	5					3 (7)				1 (little)	3 (12)	
19	Eel Pond	9	2 (little)				3 (3)		1 (little)		4 (much)		5 (much)
24	Great Harbor	6		1 (little)				4 (much)					
25	Hadley Harbor	12	7 (much)	9 (much)	9 (much)		1 (1)	4 (much)	3 (mod.)				2 (little)
Aug. 1	do	26	17 (v. much)	18 (much)	11 (much)	10 (little)	2 (2)		12 (mod.)				
6	Great Harbor	17	16 (v. much)	2 (little)		2 (little)	1 (1)						2 (little)
7	do	18	7 (much)	5 (little)		2 (little)	1 (1)						1 (little)
9	Hadley Harbor	21	10 (much)	13 (much)	5 (much)	13 (much)	4 (much)						3 (little)
13	Katama Bay	12			1 (1)	1 (21)	3 (much)	4 (much)				4 (7)	2 (much)
23	do	32	1 (little)			5 (33)	6 (10)	4 (much)				10 (16)	1 (little)
1903.													
July 10	Hadley Harbor	25	14 (much)	20 (much)	9 (much)	6 (little)	2 (4)	4 (much)		11 (much)			
19	Eel Pond	35	26 (much)	24 (much)	4 (29)	2 (little)	5 (12)	6 (much)		9 (much)	6 (much)		
Aug. 6	Hadley Harbor	23	13 (much)	16 (much)	16 (83)	2 (2)	2 (5)	1 (little)		10 (much)		1 (3)	
26	Eel Pond	16	15 (much)	8 (much)		1 (few)		1 (1)		1 (1)			
	Total[a]	306	162	122	55 (113+)	54 (56+)	42 (59+)	38 (1+)	36	31 (1+)	29	18 (38)	17
	Per cent		52.94	39.86	17.97	17.64	13.72	12.41	11.76	10.13	9.47	5.88	5.45

[a] See note on page 12.

STATEMENT OF THE FOOD OF THE CUNNERS EXAMINED—Continued.

Date.	Locality.	Specimens examined.	Number of stomachs containing— Teleost eggs.	Lady crabs.	Hydroids.	Nereis.	Hermit crabs.	Pipefish.	Matter undetermined.	Nothing.	Miscellaneous food.
1902.											
July 3	Eel Pond	8	1 (few)						1 (much)		
4	do	3							4 (mod.)		
11	do	5							3 (much)		
12	Great Harbor	6								2	
12	Eel Pond	25				2 (2)					
16	do	12					1 (2)				
18	Katama Bay	5		1 (¼)					2 (much)		
19	Eel Pond	9							1 (little)		
24	Great Harbor	6							1 (little)		
25	Hadley Harbor	12	1 (much)	3 (much)					11 (much)		
Aug. 1	do	26	4 (119)	2 (much)			2 (3)				
6	Great Harbor	17				1 (2)		1 (1)		1	1 eel.
7	do	18									
9	Hadley Harbor	21		1 (little)	3 (much)				1 (much)		4 *Solenomya* velum.
13	Katama Bay	12				1 (1)	1 (1)		1 (little)		8 sand-shrimps.
23	do	32	4 (230)				3 (much)	3 (7)	2 (much)		1 (4 *Hyas*).
											2 (4 *Panopeus*), 2 (2 *Molgula*).
1903.											
July 10	Hadley Harbor	25	1 (18)		1 (much)	2 (2)			22 (much)		2 silversides.
19	Eel Pond	35	3 (12)	1 (1)		1 (1)			13 (much)	3	2 *Pecten*.
Aug. 6	Hadley Harbor	23		1 (much)	5 (much)	1 (1)		1 (1)	6 (much)		1 Bryozoa.
											Weed stalk.
26	Eel Pond	16							4 (much)		10 isopods.
											1 stickleback.
	Total[a]	306	14 (379+)	9 (1¼+)	9	8 (9)	7 (6+)	5 (9)	72	6	
	Per cent		4.57	2.94	2.94	2.61	2.14	1.63	23.53	1.96	

[a] See note on page 12.

POSSIBLE DESTRUCTIVENESS.

It will be observed that enormous numbers of small crustaceans, principally sand fleas (Amphipoda) and the prawn (*Palæmonetes*), go to make up the cunner's food supply. Many molluscs are eaten also, the gasteropods (*Bulla* and *Odostomia*) and the pelecypods (*Mytilus*, *Pecten*, *Nucula*, and *Solenomya*) being identified. The column headed "Fish, species undetermined" most likely represents flesh picked from dead bodies of fishes, since it was invariably in pieces, with nothing to indicate that a whole fish had been swallowed. Furthermore, cunners in the Eel Pond and about the Revenue Wharf at Woods Hole were often seen feeding upon dead fish and refuse matter lying on the bottom. This is in support of Dr. Goode's statement that "they are among the most important scavengers of our harbors." Thus the cunner is a useful fish. The column headed "Teleost eggs," however, suggests that the cunner may also do evil. If the alimentary canals of 4 per cent of the cunners contain the eggs of fishes during the months of July and August, when very few fish are spawning, the question arises, how many would be found containing fish spawn in May and June, when many valuable food fishes are spawning? And since the cunner also feeds largely upon sand fleas, prawns, and other small crustaceans, is there not ground for suspicion that many young lobsters fall victims to it? Only a careful study of the cunner's food supply in various localities during May and June will give an adequate answer to these queries. Certainly, during the months of July and August the cunner, as here shown, is not a destructive fish, but rather a useful harbor scavenger.

THE TOADFISH.

GENERAL APPEARANCE, ABUNDANCE, AND HABITS.

The toadfish (*Opsanus tau*) varies from several to 16 inches in length. It has a robust body with a slimy, scaleless surface and a large broad head, bearing a wide, capacious mouth. The general color is a dusky olive, the sides being marked with indistinct blackish bars, and the whole body being sometimes spotted with yellow or whitish. In appearance it somewhat resembles a toad, and this fact gives it its name. It is quite common from Cape Cod to Cuba. On the lower Potomac River, Maryland, Smith (1892) reports it "exceedingly numerous, especially on the oyster beds in shallow water." Shoal water, which is well grown up with eel grass (*Zostera marina*) and where there are plenty of large stones and empty tomato cans, is the ideal place for the toadfish, furnishing it protection and abundance of food. The eggs are laid in some empty tin can or under a rock and guarded by the parent until the young

come forth. The fish is so ugly in appearance that it is rarely eaten. Dr. Smith states, however, that it "is sometimes eaten by the negroes and is said to be well flavored."

FOOD.

Of the food of the toadfish Verrill and Smith (1873) say:

Several specimens examined at Great Egg Harbor, N. J., April, 1871, contained young edible crabs (*Callinectes hastatus*) of various sizes up to those with the carapax 2 inches broad; shrimp (*Crangon vulgaris*); prawn (*Palæmonetes vulgaris*); *Ilyanassa obsoleta*; various fishes, especially the pipefish (*Syngnathus peckianus*), and the anchovy (*Engraulis vittatus*). A specimen caught at Woods Hole in July contained the common rock crab (*Cancer irroratus*).

Linton (1901), in his food notes of this species, records the following:

Littorina littorea, Ilyanassa obsoleta, Tritia trivittata, Urosalpynx cinerea, usually with hermit crabs; *Crepidula fornicata, Pecten irradians, Cancer irroratus, Palæmonetes vulgaris, Eupagurus longicarpus;* bones and other fragments of fish; a partly digested toadfish. I have seen a toadfish in the aquarium in the act of swallowing another of its own species but little smaller than itself. In the alimentary canal of a small specimen two shells of *Utriculus canaliculatus* (*Bulla*) were found.

EXAMINATION OF DIGESTIVE TRACTS.

Great difficulty was experienced in getting in the vicinity of Woods Hole a sufficient number of toadfish for this study. Prior to 1902 the species was considered common in that locality, but since then attempts to collect it have been almost in vain. Only very few have been found in places where they were hitherto very common. Nearly all of the 33 specimens examined in the present work were collected at the mouth of the Wareham River.

STATEMENT OF THE FOOD OF TOADFISH EXAMINED.

NOTE.—Figure outside of parenthesis denotes number of toadfish; number or amount of the species eaten is included within parenthesis.

Date.	Locality.	Specimens examined.	Number of stomachs containing—					
			Hermit crabs.	Rock crabs.	Crepidula.	Fish.	Amphipods.	Miscellaneous.
1905.								
July 2	Wareham ..	5	5 (78)	.....	5 (20)	1 (little)	.....	2 fiddler crabs. A little vegetable matter.
4	Eel pond ...	1	.....	.....	.....	1 (little)	.....	Few small crustaceans. 1 lady crab. 2 pocket crabs.
Aug. 9	Hadley Harbor.	1	1 (3)	.....	.....	.....	.....	
16	Wareham ..	4	... .	3 (9)	.....	.....	4 (29)	1 *Gobia.* 1 *Callianassa.* 3 prawns.
1903.								
July 6	Wareham ..	9	6 (29)	5 (11)	2 (6)	3 (mod.)	.....	1 common killifish. 3 pebbles.
10	Hadley Harbor.	1	1 (2)	1 (2)	.....	.....	.....	5 teleost eggs.
24	Wareham ..	12	9 (71)	10 (23)	2 (2)	.....	.....	1 (7 snails).
	Total.....	33	22 (183)	19 (45)	9 (28)	5	4 (29)	
	Per cent	.....	66.6	57.5	27.2	15.1	12.1	

ESTIMATE OF DESTRUCTIVENESS.

With such a small number of specimens as a basis, it is hardly possible to estimate the economic importance of the toadfish so far as its food is concerned. The table indicates, however, that it feeds largely upon the hermit crab (*Eupagurus longicarpus*), which usually inhabits the shell of the snail (*Littorina littorea*), so common along our shores, and which it is impossible for the toadfish to separate from the shell. As many as 15 or 20 of these snail shells containing hermit crabs have been recorded from the alimentary canal of a single toadfish, and the shells were found throughout the whole length of the intestinal tract, which makes it clear that they are eliminated by way of the anus and not regurgitated, as popularly supposed. Other crustaceans, as the rock crab (*Cancer irroratus*), pocket crab (*Panopeus depressus*), lady crab (*Ovalipes ocellatus*), prawn (*Palæmonetes vulgaris*), and *Gebia*, enter largely into the food supply of the toadfish. Small molluscs, like *Crepidula* and other gasteropods, are also eaten. Small fishes are preyed upon to some extent, and probably more so than is indicated in the table. Such species as the common killifish, cunner, and silversides are most apt to be the victims, since they frequent the places natural to the toadfish. The fact that five teleost eggs were found in a Hadley Harbor specimen suggests that the toadfish may be destructive to the eggs of fishes spawn in shoal places and in ponds connected with the sea.

The statements of Verrill and Smith (1873) and of Linton (1899) regarding the food of the toadfish compare very closely with the results here found. The diet of the toadfish consists almost entirely of crustaceans, small molluscs, and small fishes. The destruction of hermit crabs, which are valuable scavengers, and fish spawn is the principal damage done. The number of toad fish in the Woods Hole region, however, is so small that the harm done by them in that locality can not be of any serious consequence.

THE GOOSEFISH, OR ANGLER.

PECULIAR APPEARANCE AND LOCAL NAMES.

The goosefish (*Lophius piscatorius*) is well known to Atlantic coast fishermen by its singularly ugly appearance. The body is flat dorsoventrally and very broad across the head, from which it tapers abruptly back to a short tail. The mouth is very wide, is surrounded with a fringe of barbels, and has an enormous capacity. Each jaw is set with a double row of teeth, which are directed backward. The dorsal fin, of six spines, has the first of these located on the snout just behind the upper jaw and bears on the tip a flaglike membrane. In color the goosefish is a mottled brown on the upper parts, with the

under portions white. The average length of the adult is about 3 feet. The singular appearance and habits of the goosefish have gained it numerous appellations. In Massachusetts the fishermen know it by the names "goosefish," "angler," or "fishing frog." In Maine it is the "monkfish," in Rhode Island the "bellows-fish," in eastern Connecticut the "molligut," and in South Carolina "all-mouth." The early colonial writers refer to it as the "greedigut." It is also known as the "wide-gap," "kettle-maw," and "sea devil."

The goosefish is fairly common on both the east and west shores of the Atlantic. On the west coast it ranges from Newfoundland to Cape Hatteras, and on the east coast from the Shetland Islands to the Mediterranean Sea. It is most abundant in the northern waters.

REPRODUCTION.

The spawning season begins about the middle of summer. During July and August, 1905, at Menemsha Bight, great quantities of the spawn were seen in and about the fish traps. Each batch was contained in a great floating, jelly-like mass 20 or 30 feet long and 4 or 5 feet wide, which contained many thousands of eggs. The larval fish develops from the egg very rapidly, and, according to Cunningham (1896), when hatched is much more advanced in development than are the young of most fishes with separate floating eggs.

USES.

Very little commercial use has ever been made of the goosefish. It is rarely eaten by man, although the flesh is said to be palatable and used in Italy and in certain parts of Great Britain. It is sometimes used for baiting lobster pots when other kinds of bait are not available, and it has also been used with menhaden for guano.

FOOD.

The food and feeding habits of this enormously voracious fish form a subject of considerable general interest. Its reputed manner of capturing prey is very curious. Lying concealed in weed on the bottom, it is said to hold erect its first dorsal spine, which is tipped with the flag-like membrane. The "flag" serves as a lure to attract hungry and unwary fishes, which come and nibble at the tender-looking morsel; but as soon as the "flag" is touched a cavern is opened and the innocent fishes are engulfed between the jaws of the goosefish.

Several observers have written briefly concerning the food of the goosefish, and from a few of these I will quote.

Verrill and Smith, 1873:

> A specimen caught in Vineyard Sound in June contained crabs, *Cancer irroratus*, and squids, *Loligo pealii*.

Goode, 1884:

They feed upon other fish—often on large ones, their swallowing powers being practically unlimited. Mackerel, sculpins, sea ravens, dogfish, crabs, squids, and lobsters have been found in their stomachs by observers of the United States Fish Commission. They often attempt to feed on each other. The common name refers to the fact that they have been known to swallow live geese. A fisherman told me he once saw a struggle in the water and found that a goosefish had swallowed the head and neck of a large loon, which had pulled it to the surface and was trying to escape. There is authentic record of seven wild ducks having been taken from the stomach of one of them. Slyly approaching from below, they seize birds as they float upon the surface. They annoy the fishermen by swallowing the wooden buoys attached to the lobster pots. Mr. Minot, of Magnolia, Mass., caught one by using his boat anchor for a hook.

Linton, 1901:

August 30, 1887, a specimen taken south of Cuttyhunk had in its stomach a large quantity of mud which was rich in mollusks, annelids, and small crustaceans.

August 5, 1899, a small specimen had in stomach a winter flounder almost as large as the goosefish.

August 18, 1899, alimentary canal with fragments of fish.

EXAMINATION OF DIGESTIVE TRACTS.

The following table classifies the food of 46 goosefish which were collected from the fish traps at Menemsha Bight, Marthas Vineyard. From this table it will be seen that squid (*Loligo pealii*) and skates (*Raja erinacea*) constitute the chief food of the goosefish, each of these species being found in 17.39 per cent of the total number examined. Flounders (*Paralichthys dentatus*, *Lophopsetta maculata*, *Pseudopleuronectes americanus*) are eaten in large numbers, and it should be added that the specimens removed from the stomachs were all large, averaging a foot or more in length. Lady crabs (*Ovalipes ocellatus*) were present in 8 per cent of the goosefish, and undoubtedly constitute an important item in their diet. Sand eels (*Ammodytes americanus*) and squeteague (*Cynoscion regalis*) were each found on two occasions. There was also a sea robin (*Prionotus carolinus*), a butterfish (*Poronotus triacanthus*) and an eel (*Anguilla chrysypa*), besides such miscellaneous material as eel grass, two skate eggs, pieces of starfish, and a sand dollar.

STATEMENT OF THE FOOD OF THE GOOSEFISH EXAMINED.

NOTE.—Figure outside of parenthesis denotes number of goosefish; number or amount of the species eaten is inclosed within parenthesis.

Date.	Locality.	Specimens examined.	Number of stomachs containing—						
			Squids.	Skates.	Flounders.	Lady crabs.	Sand eels.	Squeteagues.	Nothing.
1905.									
July 17	Menemsha Bight[a]	9	3(9)	3(3)	4(6)	.....	.....	1(1)	2
18	do	2	.....	.....	.....	.....	.....	.....	2
19	do	1	.....	.....	.....	.....	.....	.....	1
20	do	2	.....	.....	.....	.....	.....	.....	2
21	do.[b]	8	3(5)	[c]1	.....	.....	.....	.....	4
22	do	2	.....	.....	.....	.....	2(5)	1(1)	.....
25	do	3	.....	1(1)	.....	.....	.....	.....	2
26	do	2	.....	1(1)	.....	.....	.....	.....	1
27	do.[d]	2	1(1)	.....	.....	.....	.....	.....	.....
Aug. 23	do	2	.....	.....	.....	.....	.....	.....	2
1906.									
July 14	do.[e]	10	.....	1(1)	2(2)	4(9)	.....	.....	1
Aug. 29	do.[f]	3	1(1)	1(1)	1(1)	.....	.....	.....	.....
	Total	46	8(16)	8(7+)	7(9)	4(9)	2(5)	2(2)	20
	Per cent	.....	17.39	17.39	15.21	8.69	4.34	4.34	43.48

[a] 1 sea robbin.
[b] Knot of eel grass; 2 skate eggs.
[c] Fragment.
[d] 1 butterfish.
[e] 1 eel, 21 inches long; pieces of starfish.
[f] Few fish bones; 1 sand dollar.

ESTIMATE OF DESTRUCTIVENESS.

A summary of the literature dealing with the food of the goosefish will show how wide a range of the animal kingdom is utilized. The list of species eaten includes annelid worms, echinoderms (starfish, sand dollars), squids, and other molluscs, crustaceans (lobster, rock crab, lady crab), fishes (dogfish, skates, eels, sand launce, mackerel, butterfish, squeteague, sculpins, sea raven, flounders), and water fowls (loons, ducks, geese). The great variety, however, is not the only factor of the food of the goosefish to be considered; quantity is of even greater importance. One look at the enormous mouth and capacious stomach, which together constitute about one-half of the fish, is sufficient to convince one that the amount of food consumed at one time is enormous. A single meal will sometimes approximate about one-half the weight of the goosefish. It is no wonder that the early colonial writers applied the name greedigut. The reason for such an appetite remains a puzzle, however. If all the nourishment in such meals is assimilated, where and how is the energy used? Apparently not entirely for tissue building or in active locomotion.

Data concerning the food and economic relations of the goosefish are still incomplete, but it is clear that it is a voracious consumer of certain useful food fishes, particularly the flounder. So long as the numbers do not increase greatly beyond the present abundance, however, the injury done to the fisheries by the goosefish will remain unappreciable.

METHODS OF CONTROLLING DESTRUCTIVENESS OF DOGFISH.

The study of the food of the eight fishes just considered shows that the smooth dogfish (*Mustelus canis*), the sandshark (*Carcharias littoralis*), and the horned dogfish (*Squalus acanthias*) are very destructive to our fishing industries. The two dogfishes are by far the most harmful. The smooth dogfish, as has been shown, destroys lobsters by the hundred thousand, and the horned dogfish destroys mackerel, herring, etc., by the millions, besides injuring nets, trawls, and other fishing gear to the extent of thousands of dollars' worth each year. Fishermen all along our coast are seeking means to be rid of these pests. It is quite evident that the time has come to consider carefully this serious condition and to provide some means of controlling the devastation.

INADEQUATE SUGGESTIONS.

Prince (1904) considers the reduction of the numbers of dogfish to be no easy matter and their total extermination practically impossible. He lists the suggestions offered to the Canadian government for reducing the numbers of horned dogfish as follows:

(1) Liberate alive some hundreds of dogfish, having securely fastened outside their bodies (by means of hooks, wires, etc.) glittering and gaudy streamers or jingling chains or bells, calculated to terrify and frighten away the schools of dogfish, on the old principle of setting at liberty a rat with a bell hung to its neck.

(2) Inoculate a number of dogfish with some fatal or contagious disease, thus securing the infection and death of all the schools of dogfish which may hover near, on the principle adopted in reducing the pest of rabbits in Australia some years ago.

(3) Dynamite the great schools of dogfish when they appear.

(4) Employ government cruisers and their men in capturing these pests or let the government employ special vessels for the purpose until the plague is reduced.

(5) Pay a bounty of 1 cent for every 5 tails ($2 per 1,000) * * *.

(6) Pay a bounty on basis of the weight of the dogfish captured, say, so much per 100 pounds * * *. Thus the suggested rates range from 10 to 15 cents per 100 pounds to 25 cents per 100 pounds.

(7) Pay a bounty on the total yield of oil, a fixed rate on each gallon of oil produced by a factory being guaranteed to a firm or company carrying on reduction works.

(8) Use of long seines of strong cord, 1,000 yards or more in length, under departmental direction, and surround the schools as is done with the schools of sharks in India.

Most of the above methods are inadequate for solution of the problem. Dr. Prince pointed out that the first three in the list would as likely prove harmful to valuable fishes as to the pest. Methods 4, 5, 6, and 8 would involve unnecessary expense. There is a natural tendency to jump at the conclusion that a bounty is the only way to

settle a matter of this kind. A fair bounty, to be sure, would stimulate the fishermen in their efforts to catch the dogfish. But if one will stop to consider that the number of dogfish just off the eastern American shores probably runs up into the hundreds of millions, perhaps billions, he can realize how great would be the expense involved in this method for simply reducing the number by 5 per cent. A bounty placed on the dogfish would prove to be more expensive, more useless, and more absurd than a bounty placed on the English sparrow. The most sensible and practical suggestion given above is no. 7. This method makes the dogfish to some degree pay the expense of bringing about its own destruction. But why not make the dogfish pay the whole bill, besides yielding a comfortable income to those who engage in the fishery? A consideration of the useful products which may be obtained from the dogfishes will help to show that this is possible.

POSSIBLE USES OF DOGFISHES.

Goode (1884) says that the smooth dogfish constitutes an important bait in the local fisheries of Bermuda. According to Cunningham (1896), the horned dogfish is salted down for bait by the English fishermen in some localities. It has also been dried and used for fuel on some parts of Cape Cod.

SKIN.

The skin of the dogfish is in itself a useful product. It is durable, nonporous, and covered with numerous small, pointed denticles closely set together. The denticles are spinelike in form and similar in structure to mammalian teeth, consisting of an inner portion of dentine covered by an outer layer of enamel. Each is inserted firmly into a plate of osseus tissue which lies within the skin. In other sharks the denticles are larger and much less numerous. This durable material has been used in numerous ways. Turners, cabinetmakers, and carpenters of Europe have used it for scraping and smoothing their work before polishing. Metal workers and others have used it to advantage for polishing purposes. Fishermen have long used it for polishing their metallic mackerel jigs and the woodwork on shipboard. In the East it is used for polishing ivory. In France the skin, when prepared with the placoid scales in place and dyed, usually green, is used for covering cardcases, jewel boxes, sword sheaths, desk ornaments, etc., and may also be used to advantage as a covering for the handles of such articles as swords and tennis rackets, on which it is desirable to get a firm grip. This commodity is called "galuchat."

When prepared for polishing purposes, the shark or dogfish skins are merely dried after being thoroughly cleaned of all adhering

flesh, but when prepared for leather or ornamental purposes they are tanned, generally by an alum process. The ordinary method is to soak the skins in fresh water four or five days, then in a lime-water for from two to six days, then wash them free of lime and soak them in a mixture of bran and water. They are next thoroughly fleshed and put in an alum-salt solution for two or three days, after which they are dried and are then ready for use.

LIVER.

The liver, because of its rich supply of oil, has heretofore contributed the most valuable product from the dogfish. In recent years, however, petroleum products have so largely displaced the fish oils that now the business of extracting dogfish oil has become unprofitable in many localities where formerly it was an important enterprise. Stevenson (1903) states that the livers of dogfish sell in Boston and Gloucester for 25 or 30 cents per bucket of $2\frac{1}{2}$ gallons. During August, September, and October a bucket of livers will yield 6 quarts of oil. At other seasons the yield is less. Stevenson further says that large quantities of dogfish oil are sold in Oregon, Washington, and British Columbia, owing to the high prices of other oils on the Pacific coast, and much of this oil is exported. In 1876 Victoria exported about 60,000 gallons, at 40 cents per gallon. The annual product at present is said to exceed 200,000 gallons. On the New England coast the annual product probably does not exceed 10,000 gallons, and most of this is combined with cod oil, which is sold for currying purposes.

Dogfish oil has been used for lubricating and lighting purposes. It burns with a bright flame and does not carbonize the wick. It is also used in tanneries and in steel tempering. It makes a valuable body for paints which are to be applied to out-of-door objects in exposed places. In some localities it is used in the preparation of wool for weaving. It has also been refined for medicinal uses and is claimed by some to be as good as cod-liver oil—in fact, much of the cod-liver oil sold on the market heretofore has been adulterated with dogfish oil. The constituents of the latter are about the same as those of cod oil, except in the quantity of iodine. When perfectly clean, from fresh livers, and the oil properly refined, there seems to be no reason for assuming that the dogfish-liver oil for use as a medicine is inferior to the cod.

SKELETON AND FINS.

The skeleton and fins of the dogfish are cartilaginous and rich in glue, which may be of some value. It is reported that Canada has planned to reduce the dogfish plague by operating three reduction plants, erected at a cost of $9,000 each, to convert the fish into fer-

tilizer and glue, the government to buy all the dogfish that the fishermen will bring in. An official of one of the largest glue manufactories says that all attempts to make glue from dogfish have proved failures, and he does not think that a marketable quality of glue can be obtained from that kind of fish. But simple boiling of the cartilaginous parts for a short time will extract a considerable quantity of glue which is about as good as ordinary mucilage, or perhaps even stronger as an adhesive. It remains to be seen whether the Canadian government can make a marketable quality. If the experiment is successful a new value will be created for the dogfish.

FLESH.

The flesh is perhaps the most valuable part of the dogfish, though few people have come to appreciate it. The offensive name, prejudice toward sharks in general as voracious man-eaters, and failure to prepare the fish properly for the table have prevented the dogfish from becoming one of our staple food fishes. Tenison-Woods (1882) says that the flesh of sharks as a rule contains more nutriment than any fish flesh. If this statement is correct, the dogfish, which is a shark, and which has a tender, well-flavored flesh, ought to constitute a very valuable food. In Nova Scotia, Ireland, Scotland, and Norway horned dogfish have been dried in considerable quantities as food for cattle. Pigs are said to thrive well upon this food in the winter and even cows show a great liking for it. In many parts of the world dogfish are eaten by man and even highly prized as a food. Simmonds (1879) says that in Norway the horned dogfish is considered a delicacy and is also dried as split stockfish for home consumption and for export to Sweden. Goode (1884) writes that at Folkstone, England, the smooth dogfish is dried and goes by the name of "Folkstone beef." In Bermuda it is known as the "nursefish" and highly esteemed as a food by the negroes. Smitt (1895) says of the horned dogfish:

> The flesh of the picked dogfish (*Squalus acanthias*) is quite white and free from the disagreeable smell with which the larger sharks are tainted. It is said to be fairly palatable, and it is eaten in Bohuslan both fresh, either boiled or fried, and cured, either salted or dried, in the last case usually after lyeing. So, too, in Norway, where, however, it is not much esteemed. In Scotland and in southern Europe the picked dogfish is also frequently used for food. In a dried state it is a marketable commodity.

The eggs of the dogfish are used for making puddings, pancakes, etc., and otherwise as a substitute for fowl's eggs.

Food qualities of smooth dogfish.—Some test of the food qualities of the smooth dogfish was made in July, 1903, during the course of the present investigations. Fried smooth dogfish was sampled by about a dozen members of the scientific staff of the Bureau of Fish-

eries at Woods Hole, Mass., and all acknowledged that the flesh was tender and well flavored. Some said it was like halibut, while others thought it tasted more like swordfish. The fish had been prepared by cutting it up into cross sections about three-quarters of an inch thick, soaking these in salt water for three hours, then washing in fresh water a few moments to remove most of the salt, rolling the pieces in flour and frying them in lard, using as little grease as possible. Two days later, smooth dogfish prepared in the same manner was served under the simple name of "fish" on two tables at the "mess" of the Marine Biological Laboratory. Everyone who ate of it pronounced the fish very palatable, even after learning what kind of fish he had eaten. On several other occasions smooth dogfish, fried, was served to various members of the Fish Commission staff, their wives, and friends, and all testified to its excellence. When cooked thus the flesh is somewhat dry, but very delicate in texture, tender, and sweet. It is also entirely free from bones, which gives an added pleasure to the eating of it. Under a less disagreeable name, the fish would doubtless find a ready market. Mr. E. F. Locke, superintendent of the Fisheries station at Woods Hole, writes that while in Noank, Conn., in October, 1906, he learned of shipments of dogfish and sand sharks from there to New York that fall, and their sale at 15 to 25 cents per fish.

Canning of horned dogfish.—The horned dogfish also is a good food, as is being demonstrated at the present time in Cape Breton, where, by a packer at Petit de Grat, it was first canned for market. A dozen cans of the product, packed by the method employed for salmon, were sent to the writer to be sampled, and when prepared for the table in various ways (fried, scalloped, creamed, etc.) were highly praised for flavor and palatability. The proprietor of a hotel in Nova Scotia gives the following testimonial:

> We instructed our chef to prepare the can of dogfish handed me by you in such a way as to suit our star boarders, and, with Pope, I may say, "Hard task to hit the palate of such guests."
>
> Whether a rose by any other name would smell as sweet or not, I can not tell, but masquerading under the nom de plume of "Japanese halibut" they were adjudged fine.
>
> We planked them, and consider they are well adapted for that mode of cooking. In case some would not know how to prepare them in that way, allow me to explain that we secure an oak, birch, or beech plank about 2 inches thick and get the fish made into orders or shares, lay them on the smooth plank without greasing them, as there is oil enough in the fish, and cook them in the oven, first seasoning them. The smoke and acid from the wood combine to make a most palatable dish.

The Inverness News, of Inverness, Cape Breton, under the date November 24, 1904, printed the following article:

CAPE BRETON HALIBUT, ALIAS "DOGFISH."

A representative of the News has been shown a sample of canned dogfish * * * and we must say it compares favorably with any tinned fish we have seen. It is perfectly white in color, and the flavor is excellent. There is no doubt that all that is necessary is to have this fish introduced into foreign markets in order to create such a demand for it as will enable our fishermen to find a ready sale for all the dogfish they can catch. * * * [At a hotel in Port Hood, the chef] a few days ago gave his guests, by request, some * * * prepared dogfish, which figured on his bill of fare under the nom de plume of "Cape Breton halibut." Some of the traveling guests pronounced it first class and differing very little in taste from the halibut they were used to eat. We publish below an extract from the Maritime Merchant, Halifax, of November 4, 1904, on "The dogfish as an article of commerce":

"A few more years may show us that we have been extremely slow in recognizing a good thing in the dogfish, and since he is so plentiful, and we have such incentives to destroy him, an industry may arise in this province because of him that will add to the importance, value, and more successful conduct of our fishing industry. The other day a firm in Halifax had an inquiry for 250 quintals of dried dogfish. 'Never mind what I am going to do with them,' said the inquirer, 'I can sell them at a price.' So dried dogfish may be a staple article in ten years, 'dog oil' may be as important article of commerce as cod oil, and people may even be putting up emulsions of 'dog-liver oils' for coughs and colds. And why not? The dogfish is a cleaner living fish than many of those we are accustomed to eat every day, his meat cooked fresh is said to taste like a nice quality of halibut, and the oil he renders is good enough to deceive experts as to its origin. Wherever our prejudice against the dogfish arose, we unquestionably have it, and it may be hard to shake, but it can be done, and likely will, and then the beast we have cursed with many curses will have equal honor with the cod which has yielded us so much wealth. It may be that the prevailing high price of dried cod will be the beginning of the end of our prejudice, for quite likely the inquiry for dried dogfish has originated with some one who found the prevailing price of cod too high for some export market, and realizing the unmistakable firmness of the situation, saw the advisability of obtaining a substitute if possible. What more natural than to experiment with dogfish, which opens out large and makes up into a nice looking article? Of course, even if it should be accepted in foreign markets (as we have no doubt it would) we could not assume that it would also become popular at home. But it is not necessary that it should. If we can export dried dogfish and thereby increase our trade, what more could we want? Nevertheless we believe that if our fishermen get into the habit of catching and curing it, the idea that it is edible will gradually work into the minds of the more particular people, and in another generation the prejudice against the much maligned 'dog' may vanish entirely. Is it too much, then, to hope that the present day 'scourge' may be a profit-bringing blessing in the future?"

Samples of canned dogfish have been sent to England, France, and Japan, and orders from those countries are confidently expected. An establishment at Charlottetown, Prince Edward Island, has successfully marketed an experimental pack, and a company in Halifax,

Nova Scotia, has gone into the business on a large scale, packing some two or three thousand cases in 1906 as a beginning, with the expectation of putting out as much as 50,000 cases in 1907. Both tall and flat cans are used, the product labeled "Ocean white-fish."

Dogfish are so abundant that they can be sold at a profit by the fishermen for half a cent apiece. They can also be packed at small expense. The prepared article may therefore be sold very cheaply and at the same time yield a fair profit. Stevenson (1899) gives a list and description of most of the methods employed for preserving fishery products for food, some of which might well be applied to the dogfishes. A good, dry, salt fish, meat extract, or fish flour ought to be made from them.

UTILIZATION THE SOLUTION OF THE PROBLEM.

Attempt has been made to show that the dogfishes really yield products valuable to man. If the effort to convey this idea has succeeded, it now remains for some enterprising firms to undertake the business of utilizing these fishes in one or more ways. If the Cape Breton pioneer in the packing of dogfish succeeds in making a good market for his product, a debt of gratitude will be due him by all who are affected by the fishing industries. In the writer's opinion, the only way to be rid of the excessive depredations of these fishes is to have a large and steady demand for them in the market. Mere sporadic attempts, like putting a bounty on the dogfish for a year, or even several years, will prove expensive and will have no lasting effect. Only a continuous destruction of the dogfish will keep down its great numbers below the devastating limit, and such a destruction can not be maintained unless it be made profitable. Consideration of the uses to which the fish may be put serves to show that we may perhaps look here for a practicable solution of this problem.

MEASURES ADOPTED IN CANADA.

The action of the Department of Marine and Fisheries of Canada is the first remedial measure so far in operation against the dogfish. The reduction works already referred to are located at Canso, Nova Scotia, and Shippegan, on Chaleur Bay, New Brunswick. A third plant is said to be contracted for. The works at Canso were visited by the Massachusetts Board of Fish Commissioners, who report thereon as follows:

> October 2 and 3, 1905, we personally inspected at Canso the first of the dogfish reduction works to be put into operation under the auspices of the Department of Marine and Fisheries of Canada.
>
> This establishment began operations about September 15, and was designed to reduce about 10 tons of dogfish or fish offal daily. The machinery used was furnished by the American Process Company, and is of the type generally used in menhaden factories in this country, and with certain modifications in

the whale factories of Newfoundland. At the time of beginning operations Mr. Cox was obliged to make a week's trip among the fishermen to explain the plan and to induce them to bring in the dogfish caught. As soon as shipments began to come from points outside of Canso, e. g., Arichat, Petit de Grat, etc., the Canso fishermen began to save their dogfish. The result was a great surprise to all. It had not been realized how many dogfish had been hooked and thrown overboard again. One of the fishermen had 2 trawls set with 1,500 hooks on each. He tended the first trawl as soon as the second trawl was set, and nearly every hook had a dogfish. On October 2, in spite of the fact that notice had been sent out the two days previous that, on account of the overwhelming quantities which came in, no dogfish would be received until October 4, we saw 8 loads from steamers, small schooners, and dories brought and landed upon the dock. Three dories brought 7 tons, 3 small schooners brought 17 tons, and 1 small steamer brought 8 tons—a total of 32 tons. The price paid for the fish delivered on the dock was at that time $6 per ton if livered and $5 if unlivered. These prices include the livers. Even at $4 per ton the dogfish would have been a bonanza for the fishermen. Two men in a dory could easily make $7 to $8 a day per man, catching dogfish within 1 mile of their homes.

Since our visit we learn that many improvements in the process have been developed, and several new mechanical devices are to be instituted. The results of treating the livers separately from the bodies have been much more satisfactory. The drying process has been much accelerated, and has resulted in a quality of fertilizer which more readily becomes available for plant food in the soil.

There is a probability that certain special parts may be conserved in such a manner as to be used for some of the purposes for which the yolks of hen's eggs are now demanded. The embryo dogfish ("pups") may be found to be satisfactory bait and thus be worth handling separately. Further investigation may disclose internal organs which can be converted into gelatin, after the manner of the "sounds" of sturgeon, hake, weakfish, etc. But above all, the flesh and the offal are converted into a valuable fertilizer, which will be of great assistance in increasing the crops of potatoes, fruits, and garden truck, by furnishing a type of fertilizer much needed on account of the short season for pushing the crops to the rapid maturity necessary.

We learn that the plant has been inspected and has received the approval of the officials of the Department of Marine and Fisheries. The general sentiment among the fishermen is favorable to the project. The chief objections are found among the opponents of the present government, who claim to see therein a shrewd political move. Be that as it may, the project promises the destruction of a vast number of dogfish, thereby benefiting the public and the fishermen through the improvement of the bait and food fisheries. It furnishes a market for what was previously a waste product of the fisheries, or, even worse, a waste product which was positively injurious unless removed at considerable expense. In addition, it is a direct benefit to the farmers and to all citizens and landowners, since it furnishes a valuable fertilizer readily available at a low price. It is therefore not strange that such efficient action should have strengthened the political party which made such a project possible.

EFFORTS IN MASSACHUSETTS.

Massachusetts has taken more active steps toward the solution of the dogfish question than any other of the United States. A special investigation was conducted by the State Board of Fish Commis-

sioners, and their report sets forth the amount of damage directly caused to the fishing interests by dogfish. At least 70 vessels directly by dogfish to the fishing interests. At least 70 vessels reported heavy losses, and hundreds of fishermen testify to similar misfortunes. The recommendations of the Massachusetts commissioners are for the encouragement of economic uses of the dogfish by means of a bounty to the fishermen or a subsidy to every industry directed toward the utilization of the dogfish. The utility of this fish as a cheap and wholesome food is particularly emphasized for the reason of its satisfactory taste, lack of odor, consistency when cooked or canned, and its freedom from bones. The inferior parts, it is suggested, could be used in feeding poultry and cattle. Other commercial possibilities for the dogfish are in the way of currying oil from the liver, polishing leather from the skin, and guano from the waste parts. The conclusion reached is that some plan must be put into practical operation whereby fishermen may receive a satisfactory remuneration for catching and bringing dogfish to shore. The report closes by calling attention to the following facts:

1. The annual damage by dogfish to marketable fish and fishing gear owned in Massachusetts is not less than $400,000. (See pp. 21, 22.)

2. This damage falls directly upon the fishing industry, but indirectly and ultimately upon the purchasing public.

3. The inroads of the dogfish upon the profits of the fishermen have at present a decided tendency to drive capable men from our maritime industries. If this continues the difficulty of securing men for the Navy will be greatly augmented. (Massachusetts now furnishes more men than any other State except New York.)

4. This damage is not confined to the coast of Massachusetts, but extends over practically the entire coast of the North Atlantic Ocean. The Dominion of Canada has already made a substantial move. Under the direction of its Department of Marine and Fisheries three dogfish reduction works have been established for securing oil and fertilizer from the dogfish. The industry of canning dogfish for food is being fostered by the same department and is developing with abundant promise of success.

5. On our Atlantic coast are numerous glue manufactories and menhaden rendering plants where dogfish could be converted into oil and fertilizer, provided the catching and transportation of dogfish could be made to yield a living profit.

6. The theory and practice of subsidies and protection to "infant industries" is prominent in the development of the United States. Our fishing industry is to-day sorely in need of a small degree of protection through a subsidy, bounty, or other governmental assistance, whereby an industry may be established which shall make the capture of dogfish as profitable as is the capture of the staple market fish.

RECOMMENDATION OF THE BUREAU OF FISHERIES.

The dogfish is a scourage to almost every state on the Atlantic coast. Yet so difficult is it to secure concerted action which would be effective in controlling the evil that appeal has been made to the general government. The Bureau of Fisheries, however, having no

authority to act in such a matter, is compelled to await legislation by Congress. During the session of 1906–7 the efforts of the Massachusetts commissioners and the petitions that poured in from all sections of the coast led to the introduction of a bill providing a bounty of 2 cents for every dogfish killed along the coast between Cape Hatteras and Eastport, Me. The Bureau of Fisheries, however, drafted another bill as substitute for this. (See Report of the Commissioner of Fisheries for 1906.) Instead of the proposed bounty, which was considered undesirable as a precedent as well as inefficient for results, the substitute bill proposes to vote a sum of money to be used in "determining the most effective methods of reducing the numbers of dogfish and of capturing them in wholesale quantities; in demonstrating the economic value of dogfish as a source of fertilizer, oil, and leather, and the most suitable methods of utilizing them for such purposes; and in testing the usefulness of the dogfish as food when used fresh or prepared by salting, smoking, and canning; and in developing the domestic and foreign markets for such preparations." This, it is thought, would afford a practical solution of the problem.

LITERATURE CITED.

Collins, J. W.

1884. Note on the destruction of mackerel by dogfish. Bulletin U. S. Fish Commission, vol. iv, 1884, p. 248.

Cunningham, J. T.

1896. The natural history of marketable marine fishes of the British islands. xvi+368 p., 2 maps. London.

Commissioner of Fish and Fisheries.

1904. Report of the Commissioner. Report U. S. Fish Commission 1903, p. 114.

Goode, G. Brown.

1884 and 1887. The fisheries and fishery industries of the United States, sec. i and ii. U. S. Fish Commission.

1888. American fishes. 496 p., illus. New York.

Jordan, David S.

1905. A guide to the study of fishes, vol. i, 624 p., vol. ii. 599 p., 428 illus. New York.

——— and Evermann, Barton W.

1896–1900. Fishes of North and Middle America. Bulletin No. 47, U. S. National Museum, 4 vols., 3,313 p., pl. i–cccxcii.

Kendall, W. C.

1898. Notes on the food of four species of the cod family. Report U. S. Fish Commission 1896, p. 177–186.

Kingsley, J. S.

1888. Standard Natural History, vol. iii, Elasmobranchs, p. 68–69.

Linton, Edwin.

1901. Parasites of fishes of the Woods Hole region. Bulletin U. S. Fish Commission, vol. xix, 1899, p. 267–304, pl. xxxiii–xliii.

McIntosh, W. C.
1899. The resources of the sea, as shown in the scientific experiments to test the effects of trawling and of the closure of certain areas off the Scottish shores. xvi+248 p., illus., tab.

Peck, J. I.
1894. On the food of the menhaden. Bulletin U. S. Fish Commission, vol. xiii, 1893, p. 113–126, pl. 1–8.
1896. The sources of marine food. Bulletin U. S. Fish Commission, vol. xv, 1895, p. 351–368, pl. 64–71.

Peterson, C. G. Joh.
1894. On the biology of our flatfishes and on the decrease of our flatfish fisheries. Report of the Danish Biological Station, vol. iv, 1893, p. 1–147, 2 pl., charts 1–17.

Prince, Edward E.
1904. The dogfish plague in Canada. Thirty-sixth Annual Report of Marine and Fisheries for 1903, p. xliii–lviii. Ottawa.

Scott, Andrew.
1899. Observations on the habits and food of young fishes. Proceedings and Transactions of the Liverpool Biological Society, vol. xiii, p. 90–93.

Scott, Thomas.
1902. Observations on the food of fishes. Twentieth Annual Report of the Fishery Board for Scotland, pt. iii, p. 486–541.

Simmonds, P. L.
1879. The commercial products of the sea. viii+484 p., 2d ed. New York.

Smith, Hugh M.
1892. Notes on a collection of fishes from the Lower Potomac River, Maryland. Bulletin U. S. Fish Commission, vol. x, 1890, p. 63–72, pl. xviii–xx.
1898. The fishes found in the vicinity of Woods Hole. Bulletin U. S. Fish Commission, vol. xvii, 1897, p. 85–111, pl. iii.

Smitt, F. A.
1895. A history of Scandinavian fishes, pt. ii, p. 567–1240, 246 fig. Stockholm.

Stevenson, Charles H.
1899. The preservation of fishery products for food. Bulletin U. S. Fish Commission, vol. xviii, 1898, p. 385–563, pl. i–xliii.
1903. Aquatic products in the arts and industries. Report U. S. Fish Commission 1902, p. 177–279, pl. 10–25.

Storer, David Humphrey.
1867. A history of the fishes of Massachusetts, 288 p., 16 pl. (1853–1867.) Cambridge.

Tenison-Woods.
1882. Fish and fisheries of New South Wales. xi+213 p., 45 pl.

Verrill, A. E., and Smith, S. I.
1873. Report upon the invertebrate animals of Vineyard Sound and the adjacent waters, with an account of the physical characters of the region. Report U. S. Fish Commission 1871–1872, p. 295–778, pl. i–xxxviii.

Yarrell, William.
1836. A history of British fishes, vol. ii, 628 p., illus. London.

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