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## FOOD OF THE STRIPED BASS

*By* LEO SHAPOVALOV

The striped bass is a fish that holds a place of high esteem and popularity with California sportsmen, an esteem which, if anything, is constantly increasing. Quite naturally, knowledge concerning its life history and habits are and should be of great value, in that only with such knowledge can the conservation of any game fish and other fishes which it affects be effectively carried on.

We already know a good deal about the life history of the striped bass in California, especially about its age and growth, and these facts have been gathered together most completely by E. C. Scofield in Fish

Bulletin No. 29, published in 1931 (see Bibliography). However, the greatest gaps in our records concerning the life history and habits of this species exist in our knowledge of its migrations, exact spawning places and habits, and its food. As a matter of fact, the indications are that there is a close relationship between these three phases of its life history. The State Division of Fish and Game is beginning an investigation to fill in these gaps, but since it may be some time before these studies are completed, it seems advisable at this time to present some recent findings concerning the food of the striped bass, as well as to sum up past investigations made in this direction.

Scofield (*loc. cit.*) made observations on the feeding habits and food of the striped bass in San Francisco, San Pablo, and Suisun bays and adjacent sloughs, but examined the stomachs of only one series of fish to the north or south of the Golden Gate. "On this occasion the fish were in the mouth of the Salinas River and just outside in the breakers. The entire school was feeding on Velella (Portuguese man-of-war)."

#### *Food of Striped Bass in Waddell Creek Lagoon*

Because of the lack of observations on localities outside of the above-mentioned ones the examinations of the stomachs of a series of 47 bass taken in Waddell Creek, Santa Cruz County, in the spring of 1935 by A. C. Taft and the writer are of interest. These examinations are of double interest because both young silver salmon (*Oncorhynchus kisutch*) and steelhead trout (*Salmo irideus*) were found in some of the stomachs. Although this is the first recorded case of either of these species being eaten by striped bass in California,\* it is not altogether unexpected. Scofield (*loc. cit.*, pp. 56, 57), has this to say: "Some questions regarding young chinook salmon as one of the foods of the bass have been repeatedly called to attention. During this investigation no salmon have ever been observed in the stomach of a bass. The lack of small salmon as a result of the serious depletion of this race is the probable reason none has been found in the stomachs of the voracious striped bass." A further point of interest resulting from the examination of the Waddell school of striped bass lies in their apparent selective feeding, kind of food depending upon size of fish.

Waddell Creek is a typical small coastal stream, located approximately twenty miles north of Santa Cruz. This stream has a well-developed lagoon, which is open during the winter months and ordinarily closed by a sand bar during most of the summer. During the spring of 1935, a school of striped bass was noticed near the upper end of the lagoon, in a deep hole (under the highway bridge), during the early part of March. Since Waddell Creek is being used by the California Trout Investigations as a stream for the study of the natural

\* Mr. Charles Feller, wholesale fish dealer of Marshfield, Oregon, has sent to the writer a collection of young trout and salmon from the stomachs of six striped bass taken in the Coos Bay region, Oregon, in 1930 and 1931. The young salmon were practically all silver salmon 100-140 mm. (4-5½ in.) long, evidently seaward migrants. The dates that the fish were taken, April 28 and 29 and June 2, correspond to the period of migration of seaward migrant silver salmon in California. One salmon, partly digested, was apparently a king salmon. The trout contained were larger than the salmon, the largest being 212 mm. (about 8½ in.) long. These striped bass contained 10, 11, 14, 15, 20, and 22 trout and salmon fingerlings, respectively. Unfortunately data on the size of the striped bass were not obtained, but in a letter Mr. Feller states that bass weighing six to nine pounds appear to be the most voracious feeders, rather than the larger bass full of spawn.

propagation of trout and salmon and since it was thought that the striped bass might be interfering with the normal seaward migration of the young of these fishes, it was decided to seine out the bass.

On the morning of April 26 several seine hauls were made and nearly all (47) of the bass were netted. Table 1 shows the lengths and stomach contents of these bass, the number of times each item occurred, and the total number of each item. A plus sign (+) indicates that several (uncounted number) individuals of the item were present

TABLE 1  
Stomach Contents of 47 Striped Bass, Waddell Creek Lagoon, April 26, 1935

Fish No.	Length fish in cm.	Salmon fingerlings	Salmonoid fingerlings	Salmonoid fry	Trout fingerlings	Sculpin	Sculpin ( <i>Cottus</i> )	Cobies ( <i>Parcalopobius</i> )	Sticklebacks ( <i>Gasterosteus</i> )	Unidentified fish remains	Scuds ( <i>Commensals</i> )	<i>Boesophacoma</i>	<i>Corophium</i>	Caddisfly cases	Sand, debris	Empty
1	49					2										
2	48			1												
3	47		1				3									
4	46						3									
5	45		1													
6	44														+	
7	44						1			1						
8	43															
9	43		2				2							2		
10	43		1												+	
11	43															
12	43														+	
13	43					1				1	+					
14	42									1						
15	42				1	2										
16	42		2				1									
17	42															+
18	41					1				1					+	
19	41															
20	41	3								1						
21	41										1		1			
22	41									1					+	
23	40										1				+	
24	40							2								
25	38							1			+					
26	37	2														
27	37							1			+					
28	31								2	3						
29	31								1							
30	26										+					
31	26										+					
32	26										+					
33	26							4			+					
34	26										+					
35	25							1			+					
36	25							1			+					
37	25										+					
38	25										+					
39	25										+					
40	24										+					
41	24							5			2					
42	23										+					
43	23										2					
44	22										+					
45	21							3			+					
46	20										+				+	
47	20							3			1					
Number of times item occurred		2	5	1	1	4	5	9	2	6	24	5	7	1	5	3
Number of each item		5	7	1	1	6	10	21	3	8	+	+	+	2	+	+

Plus sign indicates several (uncounted number) individuals.  
1 inch=2.54 centimeters (cm.).  
=25.4 millimeters (mm.).

in the stomach. Figure 64 gives a graphic representation in percentages of the types of food that the bass were eating.

It is interesting to note from Table 1 that the larger striped bass had been feeding largely on salmon, trout, and sculpins (cottoids, bullheads), while the smaller bass had been feeding almost entirely on small crustaceans and the small sticklebacks (*Gasterosteus*) and gobies (*Eucyclogobius*). Six of the larger 22 bass had stomachs that were empty or contained only sand and debris, but all of the others with the exception of one had been eating fish and only four had anything except fish in their stomachs. Eight of these larger fish had trout or salmon in their stomachs. Several of the eight and some of the others contained sculpins.

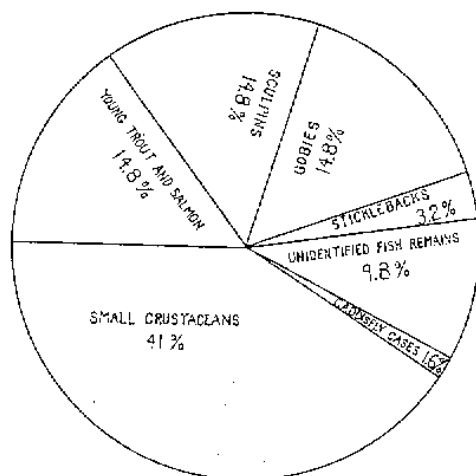


FIG. 64. Percentages based on number of times of occurrence of types of food eaten by 47 striped bass seined from Waddell Creek lagoon April 26, 1935.

Of the twenty-five smaller bass, one had an empty stomach and all the rest but two had been feeding on small crustaceans (*Gammarus*, *Corophium*, and/or *Exosphaeroma*). And of these twenty-five only one had fish other than sticklebacks and gobies in its stomach. This is indeed a remarkable case of selective

feeding, especially in view of the fact that the fish had remained as one school in the one hole for over a month. It is clearly brought out by Figure 65.

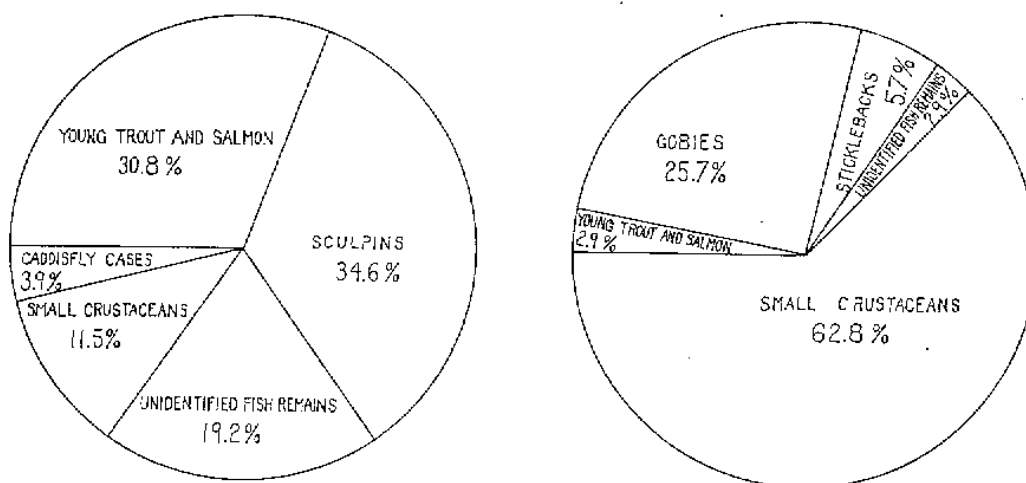


FIG. 65. Percentages based on number of times of occurrence of types of food eaten by the larger (left diagram) and by the smaller (right diagram) of 47 striped bass seined from Waddell Creek lagoon April 26, 1935.

It is of importance to note that the striped bass were present in the stream just about the time of the beginning of the seaward migration of the fingerling silver salmon and steelhead and that they were in a position in which they could intercept all of these fish. The exact time of the migrations of the young trout and salmon in Waddell Creek is

known through the operation of a trap which detains fish moving up or down the creek.

Striped bass have entered Waddell Creek in various years. Scofield (*loc. cit.*) was not inclined to consider these or other striped bass found along the coast south of San Francisco Bay as a population separate from the striped bass of the San Francisco Bay region on the basis of seine hauls made in Salinas River and Waddell Creek during May, 1927. These seine hauls revealed (1) the absence of ripe bass (during what in other localities is the height of the spawning season) and the absence of small fry which would be the result of a spawning in this area and (2) the presence of only the second, fifth, sixth, seventh, and eighth year classes and the total absence of the third and fourth year classes.

The first contention is not entirely correct, in that in the present series of examinations, although the sexual products in most of the bass were in an immature stage, one of the males (48 cm.) possessed large, white testes, from which a little milt was obtained.

The second point is entirely disproved by the examination of the present series of bass. Over one-half of the forty-seven fish caught were of the third and fourth year classes, with the possibility that several of the larger fish were of the fifth year class.

At this time it might be interesting to include records of two one-year old bass seined in Waddell Creek lagoon on April 26, 1932, by J. H. Wales and the writer. The records are as follows:

	No. 1	No. 2
Standard length-----	98 mm.	98 mm.
Length to fork of caudal-----	114 mm.	113 mm.
Stomach contents-----	<i>Corophium</i> 24, <i>Gammarus</i> 4	<i>Corophium</i> 17, <i>Neomysis</i> 1, Midge larva 1.

*Corophium*, *Gammarus*, and *Neomysis* are small crustaceans.

A. C. Taft and J. H. Wales also seined in Waddell Creek lagoon, on November 24, 1931, and in one of several seine hauls obtained two dozen striped bass, as well as finding a large, dead striped bass. Measurements were not made of these striped bass but Mr. Taft says they were of approximately the same size composition as those shown in Table 1. An examination of the stomachs of ten of these bass revealed them to be entirely empty.

At what time of year the above bass entered Waddell Creek must of course remain a matter of conjecture. Since the mouth of the creek opened on November 13, following the first fall rains, they could have come in at this time, or they may have remained in the lagoon over the summer, while the lagoon was closed.

The writer also found a small dead striped bass (length 260 mm.) in Waddell Creek lagoon on March 23, 1934.

#### *Food of Striped Bass in the San Francisco Bay Region*

During the spring of 1935 Mr. H. B. Nidever of the Bureau of Commercial Fisheries collected a series of stomachs of striped bass taken in San Francisco Bay and adjacent waters by hook and line. These were examined by Mr. G. H. Clark of the same bureau, who has kindly

turned over the data to the writer. These data are shown in Table 2. It will be noticed that most of the stomachs were empty and that several of those not empty contained material undoubtedly being used as bait (sardine heads and herring). It is interesting to note that most of these fish were collected about the same time as the series of fish from Waddell Creek lagoon.

Seofield (*loc. cit.*) lists the feeding of the striped bass as being "the heaviest between April and the following October." The above series of empty stomachs, taken mostly in April and May, shows that this is not always the case. However, the fact that the fish were taken by hook and line may be a factor, in that the fish caught may have been the particular individuals that were hungry and therefore taking bait, out of a large number of fish present.

Further evidence that striped bass do not always feed during the summer months is contained in the report of Edwin Linton (1901). He writes: "The stomachs of all the specimens which I have examined have been empty. A few fish scales have been noted in the intestine."

TABLE 2

Stomach Contents of 43 Striped Bass from San Francisco Bay and Adjacent Waters, March 28 to May 15, 1935

No. and locality	Date	Length	Weight	Sex	Stomach contents
1. Brick Yard, Sac. R....	3/28/35	18 in.	-----	-----	1 fish vertebra 3 in. long
2. Brick Yard, Sac. R....	4/ 1/35	18 in.	-----	M	1 head and $\frac{1}{4}$ body of herring
3. Pt. Richmond.....	4/ 3/35	-----	4 $\frac{1}{2}$ lbs.	-----	One 10 in. Jack Smelt; seven smelt 3.5 in. to 5 in.; one perch 5.5 in.; scales of 4 yr. Striped Bass
4. Pittsburg.....	4/10/35	20 in.	4 lbs.	M	Empty
5. Pittsburg.....	4/10/35	21 in.	4 lbs.	-----	5 in. Striped Bass
6. Pittsburg.....	4/10/35	24 in. (?)	9 lbs.	-----	Empty
7. Pittsburg.....	4/10/35	22 in.	4 lbs.	F	Empty—tumor on stomach
8. Pittsburg.....	4/10/35	24 in.	5 lbs.	-----	Empty
9. Pittsburg.....	4/10/35	22 in.	4 lbs.	M	Empty except for small piece of tulle
10. Pittsburg.....	4/10/35	21 in.	3 $\frac{3}{4}$ lbs.	M	Empty
11. Pittsburg.....	4/10/35	-----	4 $\frac{1}{2}$ lbs.	-----	Empty
12. Pittsburg.....	4/10/35	-----	8 lbs.	-----	5 in. two-dorsaled fish
13. Pittsburg.....	4/10/35	-----	-----	-----	3 in. head of sardine or herring
14. Pittsburg.....	4/10/35	-----	-----	-----	Empty
15. Pittsburg.....	4/10/35	-----	-----	-----	Empty
16. Pittsburg.....	4/10/35	20 in.	3 $\frac{1}{2}$ lbs.	M	Empty
17. Pittsburg.....	4/10/35	21 in.	-----	M	Empty
18. Pittsburg.....	4/10/35	-----	-----	-----	Empty
19. Pittsburg.....	4/10/35	-----	-----	-----	Empty
20. Pittsburg.....	4/10/35	22 in.	-----	M	Empty
21. Pittsburg.....	4/10/35	22 in.	4 lbs.	M	Empty
22. Pittsburg.....	4/10/35	-----	-----	-----	Empty
23. Honker Bay.....	4/15/35	-----	-----	-----	Empty
24. Above Dutch Slough..	4/19/35	-----	10 lbs.	-----	Empty
25. Pittsburg.....	4/19/35	-----	4 lbs.	-----	Empty
26. Antioch Bridge.....	4/19/35	-----	7 $\frac{1}{2}$ lbs.	-----	Empty
27. (?).....	(?)	-----	-----	-----	Empty
28. Broad Slough.....	4/19/35	-----	3 $\frac{1}{2}$ lbs.	-----	Empty
29. Berkeley Flat.....	4/25/35	-----	5 lbs.	-----	Three 4 in. Striped Bass; four smelt; three anchovies
30. Rio Vista.....	4/27/35	-----	5 lbs.	-----	Empty
31. Rio Vista.....	4/30/35	12 in.	-----	-----	Empty
32. Rio Vista.....	4/30/35	-----	11 lbs.	-----	Empty
33. Sacramento River, Mouth Feather River	5/1-15/35	-----	-----	-----	Sardine head
33. Sacramento River, Mouth Feather River	5/1-15/35	-----	-----	-----	Sardine head and body; small unidentified fish head
35. Sacramento River, Mouth Feather River	5/1-15/35	-----	-----	-----	Piece of weed and 3 Striped Bass scales
36. Sacramento River, Mouth Feather River	5/1-15/35	-----	-----	-----	Empty
37. Rio Vista.....	5/ 1/35	-----	10 lbs.	-----	Empty
38. Rio Vista.....	5/ 5/35	-----	6 lbs.	-----	Empty except for $\frac{1}{2}$ crab
39. Rio Vista.....	5/ 5/35	-----	4 $\frac{1}{2}$ lbs.	-----	Empty
40. Mouth American River	5/ 5/35	-----	7 lbs.	-----	Remains of two sardine heads and napes
41. Rio Vista.....	5/ 6/35	-----	9 lbs.	-----	Empty
42. Rio Vista.....	5/10/35	-----	11 $\frac{1}{2}$ lbs.	-----	Empty
43. Rio Vista.....	5/14/35	-----	9 $\frac{1}{2}$ lbs.	-----	Empty

All of the specimens of striped bass mentioned by Linton were collected from July 14–August 18, 1886–1900, in the Woods Hole region, off the coast of Massachusetts.

*Published Accounts of the Food of the Striped Bass*

At this point it might be valuable to summarize and review our knowledge of the food of the striped bass, as contained in previously published articles both in California and on the Atlantic coast. Papers referred to here will be found listed more fully in the bibliography at the end of this article.

*Food on the Atlantic Coast*

A. E. Verrill (1873, p. 514) makes the following notes:

"At Great Egg Harbor, New Jersey, April, 1871, several specimens, freshly caught in seines, with menhaden, &c., contained *Crangon vulgaris* (shrimp) in large quantities.

"A specimen caught at Wood's Hole, July 22, 1872, contained a large mass of 'sea-cabbage,' *Ulva latissima*, and the remains of a small fish.

"Specimens taken at Wood's Hole, August, 1871, contained crabs, *Cancer irroratus*; and lobsters, *Homarus Americanus*."

On p. 73, Spencer F. Baird (1889) says the following:

"There are comparatively few fishes within our knowledge that certainly eat sea-weed as a portion of their food, although it is said that the stomach of the striped bass frequently contains such quantities of ulva and other succulent vegetation as to render it almost certain that it must have taken it as an article of food. Not unfrequently the vegetable contents of the stomachs of certain fishes may have been taken in accidentally in connection with some shrimp or mollusk which was resting upon it at the time of capture."

Gideon Mosher (1883), who at the time had been engaged in the bass fishery for 45 years, 30 or 40 years of which he had been in the habit of preparing bass for market, claimed that striped bass do not feed on menhaden. Out of tens of thousands of striped bass he had prepared, he had never found menhaden in them, unless it had been fed to them for bait. He further observes that bass fishing is best where crabs and lobsters are most plentiful.

A U. S. Bureau of Fisheries Memorandum, quoted by Scofield and Bryant (1926), makes the following statement: "The striped bass is reputed to be a voracious fish preying largely upon smaller fishes, and is particularly abundant at the time of the spring runs of shad and alewives or river herring. At this season it is well fed and plump. To some extent it frequents the rocky shores and beaches of bays and sounds at high tide in search of crabs, shrimp and other food, and, at the mouths of creeks, smaller individuals lie in wait for the schools of smaller fishes and crustaceans which supply them with food. It also subsists upon mollusks, sea worms, etc."

The present writer wishes to call attention to the part in the above passage which reads: "The striped bass \* \* \* is particularly abundant at the time of the spring runs of shad and alewives or river herring." We do not have alewives in California, but the shad, intro-

duced from the Atlantic coast, is a well-established resident of the Sacramento River, so that the above quotation may have a direct bearing on the situation in our state. During the past two years considerable numbers of young shad have been reported, on reliable authority, as occurring in the stomachs of striped bass taken in the Sacramento River and adjacent waters, between February and May.

#### *Food on the Pacific Coast*

Leaving the Atlantic coast and examining reports from California, we find the following accounts. Hugh M. Smith (1896, p. 454) reported:

"The introduced carp appears to be the principal food of the striped bass in California, and in the fresh waters is the almost exclusive food. Mr. Babcock has opened hundreds of bass for the purpose of ascertaining the nature of their food, and has never seen any other fish than carp in their stomachs. He has heard, however, of small catfish being found in them. Mr. Alexander's examination of many bass in the San Francisco market showed that whenever food of any kind was present in the alimentary tract it was in nearly every instance carp. A 10-pound carp is said to have been found in the stomach of one bass. His conclusions are that, taking the season through, carp will be found in the stomachs of 7 out of every 10 bass sold in San Francisco or caught in the rivers.

"At Capitola, on Monterey Bay, crabs have been taken from the stomachs of bass, and it is probable that in the salt water a great variety of fish food is ingested."

These statements seem rather surprising and difficult to take literally, in the light of more recent examinations. Since there are still a great many carp in the Sacramento River, one would think that they would be encountered in the stomachs of striped bass in approximately the same frequency as formerly, but the records do not show this, and conversely, one would think that Alexander in the course of examination of "hundreds of bass" would have found at least a few split-tails, hardheads, Sacramento pike, or other native minnows or fresh-water sculpins (cottoids) in their stomachs. Also, at the time of Alexander's report the salmon were still abundant in the Sacramento River, so it is surprising that at least a few were not encountered in the stomachs examined by Alexander.

Scotfield and Coleman (1910, p. 114) list the food of the adult striped bass in the rivers as mainly carp, hardheads, and split-tails and say that the fishermen claim that when the carp is plentiful it is their principal food.

Concerning the food of young bass, they have this to say:

"An examination of the stomachs of fifty young bass averaging 3 inches in length, which were taken at 'Morrison's Bite' in Napa Creek on September 10, 1908, shows the following contents: Crustaceans, a species of Mysis, 30 per cent; of young shrimp, 15 per cent; of a species of Gammarus, 1 per cent; of an Isopod, 1 per cent; and 1 small crab. Marine worms or annelids, a species of Nereis, 45 per cent; of species not recognizable, 5 per cent; small fish, species not recognizable, 2 per cent.



"It will, therefore, be seen that on this feeding ground, at least, marine worms comprise 50 per cent of the food, crustaceans of marine species 48 per cent, and small fish only 2 per cent. The young shrimp and young fish were taken from the stomachs of young bass of 3 or 4 inches in length and the other small crustaceans from the stomachs of specimens 3 inches and under in length, showing that the young bass begin feeding on the small species of crustaceans and worms, and as they grow in size are able to take the shrimp and young fish."

Evidently there was an error in the identification of the small crustaceans listed as *Mysis*. *Mysis relicta*, a fresh-water form that occurs typically in deep lakes, is the only species of *Mysis* found in North America, and the crustaceans listed by Scofield and Coleman were likely *Neomysis*, a typically brackish water form that is common in Waddell Creek lagoon and in other coastal stream lagoons. *Neomysis* was found in the stomach of a young striped bass taken in Waddell Creek lagoon in 1932 by J. H. Wales and the writer. *Gammarus* is also a fresh or brackish water form and should not be listed as a marine crustacean.

Scofield and Bryant (1926) say that fishermen occasionally find a dead striped bass with a catfish caught in its throat by the spines and also that catfish weighing up to two pounds appear to be a common item in the diet in the sloughs.

E. C. Scofield (1928.2, p. 37) has this to say: "\* \* \* We have found that the migrations or movement of the bass within the bay (San Francisco) and along the coast are largely dependent upon the food they are seeking. During the warm summer months the bass school on the mud flats. There, also, is the small feed of these ravenous eaters. In the fall, when the cold weather sets in, they leave the flats, and with them go the smaller fishes."

Quoting further: "\* \* \* A wide variety of foods has been found in their stomachs. Crabs and shrimps are their main diet, but we have found that they eat almost anything they can get into their mouth lengthwise. Any food that is plentiful, such as crab and shrimp, appears to be their favorite. Small smelt occur in great numbers in the summer months and they are ravenously eaten by the bass. We once extracted a thirteen-inch split tail from a nineteen-inch bass. Exceptionally large crabs, smelt and bullheads are not uncommon in their stomachs. They eat their own young in great quantities. Other varieties of food removed from their stomachs are softshell crabs, clams, periwinkles, piling worms, herring, gobies, minnows, sticklebacks, sand fleas and grass. Bass will follow a school of fish for miles if the water is clear. Where there are sea gulls and pelicans flying over the water one is sure to find a school of small fish, and there also will always be a school of feeding bass."

In his other paper of the same year (1928.1) Scofield largely covers the material contained in the above-quoted paper and in his bulletin of 1931 (Scofield 1931).

In the latter paper he makes the note that the study of the food of the striped bass was given a minor consideration in the report, only the essential facts of their feeding habits being covered. The material contained on the food of the striped bass in the latter paper may be summed up as follows:

1. The striped bass are voracious eaters. Practically every marine form common to the San Francisco Bay region has been found in their stomachs. Their food includes fishes, such as small Pacific herring, smelt, anchovies, split-tails, striped bass, shad, gobies, carp, and perch; crustaceans and mollusks: crabs, shrimps, periwinkles, clams; and various other forms such as worms, copepods and *Veilella*.

2. Bass feed heaviest during the spring and summer months. Spawning bass feed while on their spawning beds.

3. The bass feed heavier in the salt water.

### *Bait Taken by Striped Bass*

Almost every variety of live and dead bait has been used at various times to successfully catch striped bass. This list includes sardines, clams, bullheads, drawings from wild ducks, breasts of mud hens and skinned small birds such as linnets, sparrows, etc., live split-tail and Sacramento pike, etc. One writer claims catching a bass on a watch and another mentions cleaning a bass that contained a chicken foot in its stomach.

### *Feeding Habits of Striped Bass*

Concerning the feeding habits of the striped bass, Hubback (1927) has the following interesting account:

"Several curious experiences have convinced me that bass are able to cast a phosphorescent glow when feeding at night. I was camping by a brackish lagoon one very dark night when I heard a bass rush something in the weeds not more than ten feet from where I was sitting. Naturally, I watched the place from which the noise came, and was amazed to see a glow on the water, sufficient to enable me to see the outline of the weeds and grass clearly, and even the bubbles on the water three or four inches from the light. After the glow I heard the fish rush and make that popping or sucking sound. The entire performance was repeated six times. Another time, about the same thing happened to me on the Salinas River. I should be glad to hear from others on this subject as I was afraid of being doubted, so hesitated to tell of my experience."

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