THE FISHES OF THE SALTON SEA

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The original fish fauna of the present Salton Sea came from the Colorado River. Undoubtedly most of the species in the lower Colorado were carried into the Salton Sink when the Sea was formed in 1905 and 1906. Unfortunately no records exist of the early fauna, but fishes were said to be very abundant (Evermann, 1916). As the waters became more saline, because there was no outflow, there was a depletion of the original freshwater fish stock. Evermann (1916) reported that, as late as May 1916, there was still a sizeable population of freshwater forms, despite the fact that the water was "quite brackish, strongly alkaline, and very warm." He listed the following:

1. Carp, *Cyprinus carpio* Linnaeus—the most abundant species.
2. Bonytail, *Gila robusta* Baird and Girard—not uncommon, though Evermann saw no specimens.
3. Humpback sucker, *Xyrauchen texanus* (Abbott)—rather common, but the several seen by Evermann had a starved appearance.
4. Rainbow trout, *Salmo gairdneri* Richardson—listed by Evermann as *Salmo pleuriticus* Cope. Miller (1950) interpreted all Salton Sea records of *Salmo clarki pleuriticus* as having been based upon rainbow trout washed into the Sea from Arizona. Everman reported, "It is said to be fairly common. I saw one fine example about 16 inches long. It was in excellent condition, albeit somewhat bleached in color."
5. Striped mullet, *Mugil cephalus* Linnaeus—the second most common species.
6. Desert pupfish, *Cyprinodon macularius* Baird and Girard—found in Figtree John Spring.

Although salinities had increased greatly, two freshwater fishes were still present in 1929 (Coleman, 1929). The carp and bonytail had disappeared, but the "Colorado River trout" was occasionally seen near the east end of the Sea, and the humpback sucker was reported as rather common. The mullet had become scarce. The desert pupfish was common along the north shores of the Sea. The mosquitofish, *Gambusia affinis* Baird and Girard, was found for the first time, and was abundant at several points along the shore.

In 1929 and 1930, large plants of striped bass, *Roccus saxatilis* (Walbaum) were made, but there is no record that any of these survived. On November 13, 1930, 500 longjaw mudsuckers, *Gillichthys mirabilis* Cooper, from San Diego Bay evidently were the start of the present population in the Salton Sea. During 1934, a load of 15,000 silver salmon, *Oncorhynchus kisutch* (Walbaum), presumably fingerlings, was dumped into the Sea, never to be seen again.

TABLE 25
Known Fish Introductions into the Salton Sea *

Date	Number	Species	Common Name**	Where Acquired
20 Oct 1929.	900	*Roccus saxatilis*	striped bass	Tracy, California
24 Oct 1929.	1,500	*Roccus saxatilis*	striped bass	Tracy, California
21 Oct 1930.	1,800	*Roccus saxatilis*	striped bass	Tracy, California
13 Nov 1930.	500	*Gillichthys mirabilis*	longjaw mudsucker	San Francisco Bay
1934.	15,000	*Oncorhynchus kisutch*	silver salmon	San Diego Bay
2 Oct 1948.	43	*Anchoa mundeoloides*	anchovy	Forest Home Hatchery
23 Dec 1948.	1,000	*Cetengraulis mysticetus*	anchoveta	Guaymas
	12	*Caranx caballus*	green jack	San Diego (tuna boat)
10 May 1950.	5,000	*Cetengraulis mysticetus*	anchoveta	San Diego (tuna boat)
12 May 1950.	29	*Albula vulpes*	bonefish	San Felipe
	2	*Cetengraulis mysticetus*	anchoveta	San Felipe
	1	*Paralichthys aestuarius*	halibut	San Felipe
	40	*Colpichthys regis*	silverside	San Felipe
	1	*Eucinostomus argenteus*	spotfin mojarra	San Felipe
	2	*Trachinotus paitensis*	paloma pompano	San Felipe
	27	*Cynoscion xanthulus*	orangemouth corvina	San Felipe
	14	*Cynoscion parvipinnis*	shortfin corvina	San Felipe
	1	*Cynoscion macdonaldi*	totuava	San Felipe
	7	*Menticirrhus undulatus*	California corbina	San Felipe
	1	*Menticirrhus nasus*	corbina	San Felipe
	15	*Micropogon megalops*	croaker	San Felipe
	57	*Bairdiella icistius*	bairdiella	San Felipe
14 Dec 1950.	25	*Mugil curema*	white mullet	San Felipe
	600	*Colpichthys regis*	silverside	San Felipe
	1	*Paralichthys woolmani*	halibut	San Felipe
	1	*Scomberomorus concolor*	Monterey spanish mackerel	San Felipe
	1	*Menticirrhus undulatus*	California corbina	San Felipe
	12	*Eucinostomus argenteus*	spotfin mojarra	San Felipe
		Eucinostomus gracilis	mojarra	San Felipe
15 Dec 1950.	15	*Mugil cephalus*	striped mullet	San Felipe
	60	*Mugil curema*	white mullet	San Felipe
	70	*Colpichthys regis*	silverside	San Felipe
	1	*Nematistius pectoralis*	roosterfish	San Felipe
	1	*Menticirrhus undulatus*	California corbina	San Felipe
	75	*Eucinostomus argenteus*	spotfin mojarra	San Felipe
		Eucinostomus gracilis	mojarra	San Felipe
28 Mar 1951.	30	*Cetengraulis mysticetus*	anchoveta	San Felipe
	300	*Leuresthes sardina*	grunion	San Felipe
	3	*Cynoscion xanthulus*	orangemouth corvina	San Felipe
	2	*Cynoscion parvipinnis*	shortfin corvina	San Felipe
31 Mar 1951.	48	*Albula vulpes*	bonefish	San Felipe
	6	*Anchoa mundeoloides*	anchovy	San Felipe
	8	*Cetengraulis mysticetus*	anchoveta	San Felipe
	5	*Mugil curema*	white mullet	San Felipe
	3	*Colpichthys regis*	silverside	San Felipe
	4	*Paralichthys aestuarius*	halibut	San Felipe
	140	*Hypsopsetta guttulata*	diamond turbot	San Felipe
		Etropus crossotus	flounder	San Felipe
	65	*Anisotremus davidsoni*	sargo	San Felipe
	12	*Paralabrax maculatofasciatus*	spotted bass	San Felipe
	7	*Girella simplicidens*	opaleye	San Felipe
	2	*Halichoeres*(?)	wrasse	San Felipe
	200	*Cynoscion xanthulus*	orangemouth corvina	San Felipe
		Cynoscion othonopterus	scalyfin corvina	San Felipe
		Cynoscion parvipinnis	shortfin corvina	San Felipe
		Cynoscion macdonaldi	totuava	San Felipe
	10	*Bairdiella icistius*	bairdiella	San Felipe
	2	*Menticirrhus nasus*	corbina	San Felipe
	1	*Eucinostomus argenteus*	spotfin mojarra	San Felipe
	63	*Gillichthys seta*	mudsucker	San Felipe
14 Dec 1951.	72	*Colpichthys regis*	silverside	San Felipe
11 May 1953.	6,000	*Engraulis mordax*	northern anchovy	Los Angeles Harbor
13 May 1953.	44	*Cynoscion parvipinnis*	shortfin corvina	San Felipe
	35	*Micropogon megalops*	croaker	San Felipe
	4	*Menticirrhus undulatus*	California corbina	San Felipe
	1	*Trachinotus paitensis*	paloma pompano	San Felipe

TABLE 25—Continued

Known Fish Introductions into the Salton Sea *

Date	Number	Species	Common Name**	Where Acquired
	26	*Opisthonema libertate*....	Pacific thread herring..	San Felipe
15 May 1953.	50	*Cynoscion parvipinnis*..	shortfin corvina.....	San Felipe
	33	*Cynoscion xanthulus*....	orangemouth corvina..	San Felipe
	4	*Menticirrhus undulatus*.	California corbina.....	San Felipe
10 Mar 1955.	3,000	*Cetengraulis mysticetus*.	anchoveta.....	Gulf of California
10-11 May 1955.	114	*Cynoscion parvipinnis*..	shortfin corvina.....	San Felipe
	4	*Cynoscion xanthulus*....	orangemouth corvina..	San Felipe
Apr-May 1956.	8	*Cynoscion macdonaldi*..	totuava.....	San Felipe
	1	*Cynoscion othonopterus*.	scalyfin corvina.....	San Felipe
	1,845	*Cynoscion parvipinnis*..	shortfin corvina.....	San Felipe
	69	*Cynoscion xanthulus*....	orangemouth corvina..	San Felipe

* Prepared by John E. Fitch.
** Common family name used when no specific common name is available.

Dill and Woodhull (1942) reported numerous machete or ten-pounders, *Elops affinis* Regan, at various localities in the Sea, but there have been no subsequent records. Presumably there was not sufficient suitable food to support a carnivorous fish at that time.

In 1948 the California Department of Fish and Game resumed efforts to establish additional fish species in the Sea. In 1950 and 1951, they made large plants of many species secured from the Gulf of California at San Felipe, Baja California. The present populations of bairdiella, orangemouth corvina, and sargo resulted from these plantings. Subsequent introductions were also made in 1953, 1955, and 1956, but they probably had no significant effect.

Many of the plants made during and after 1950 were of the "shotgun" type. Since there was no way to predict what fishes might be successful, many species were introduced. All fishes known to have been introduced into the Salton Sea are listed in Table 25.

The fish fauna of the Salton Sea now consists of the nine species listed below.

THREADFIN SHAD, *Dorosoma petenense* (Günther)

(Figure 26)

The threadfin shad, family Clupeidae, was brought into California in 1953 from its native waters in the southeastern United States. In 1954 and 1955, it was introduced into the Colorado River, and it quickly spread throughout the lower river system. It was first taken in the Salton Sea, which it had entered via irrigation laterals, in September 1955. There has been no sign that this species spawns in the Sea, but there is a continuing recruitment from the Colorado River system. At times they are present in large numbers.

Recognition Characters

Threadfin shad reach lengths of nearly nine inches in the Salton Sea. They may be recognized by their single dorsal fin with an elongated posterior ray, much compressed body, extremely elongate anal fin, and bright silvery color.

FIGURE 26. The threadfin shad, *Dorosoma petenense* (Günther). Photo by W. J. Baldwin.

Importance

They form an important item in the diet of the corvina. They are a desirable addition to the food chain, because they feed directly on the tiny animals in the plankton.

DESERT PUPFISH, *Cyprinodon macularius* Baird and Girard

(Figure 27)

The desert pupfish, family Cyprinodontidae, is the only native species in the Salton Sea. Its range includes the basin of the lower Colorado and Gila Rivers, from southern Arizona to southeastern California and eastern Baja California, and the Sonoyta River of northern Sonora, Mexico (Miller, 1943). Pupfish are everywhere about the shores of the Salton Sea where there is quiet water, and penetrate a few of the streams that enter the Sea. They are especially abundant in the hypersaline shore pools behind the wave built sand bars. In these pools, they tolerate extreme environmental conditions. Temperatures often exceed 99 degrees F. in summer, and sink as low as 35 or 36 degrees F. in winter. They have been known to survive and spawn in these pools when the salinity has exceeded twice that of sea water.

The food habits of the pupfish were not studied in detail, but a few observations indicated that they were similar to those of the bairdiella. The pupfish are not considered serious competitors, however, because of their small population size. They are preyed upon by the large wading birds and by the longjaw mudsuckers and bairdiella, but they are not important in the diets of any of these.

The population density fluctuates through a wide range even in areas where no predators are found. Growth is very rapid, and fish hatched in the early summer mature and spawn in the same summer. The maximum size attained is about 45mm standard length. Scale readings indicate that they attain this in one year or less.

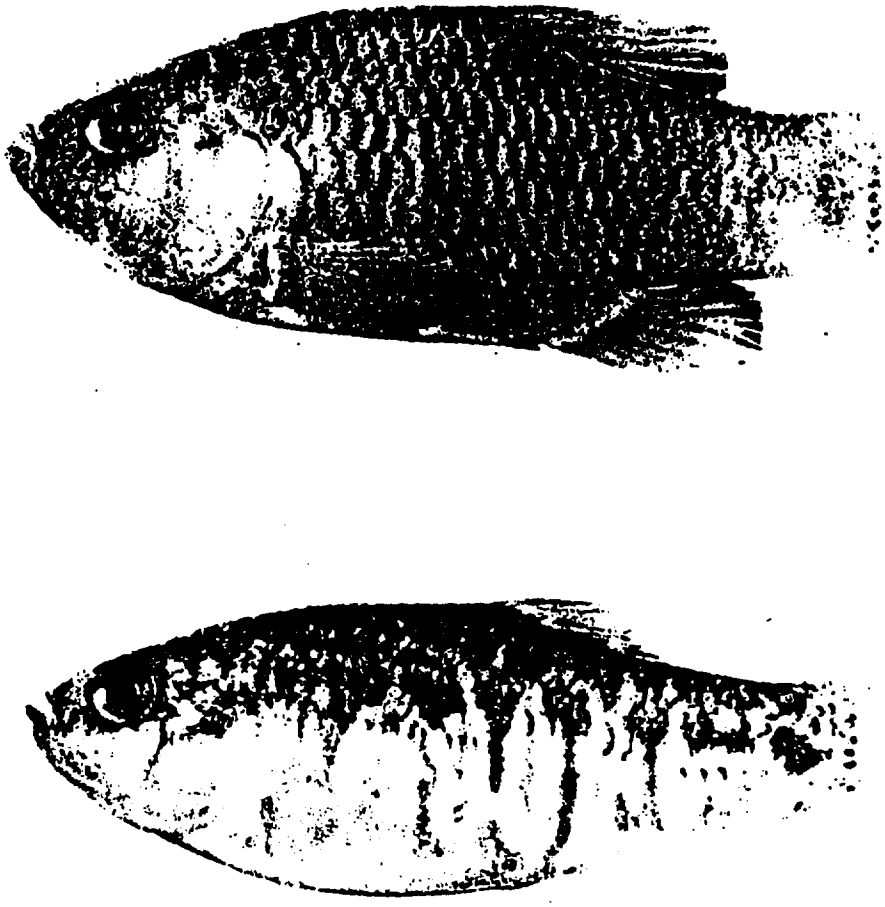

FIGURE 27. The desert pupfish, *Cyprinodon macularius* Baird and Girard. Male above, female below. Photo after R. R. Miller (1943).

Recognition Characters

Pupfish are small chubby fish, usually not over two inches long. The males are brightly colored during the summer, with blue backs and golden bellies. In the winter the colors are duller, often fading to brown or olive on the back and white on the under surface. The females are marked with definite brownish blotches on a pale background. The thick body, small size, color, and single dorsal fin distinguish them from all other fishes in the Sea. The only species with which they might be confused is the mosquitofish. Mosquitofish differ markedly in color, being uniformly tan with tiny black spots, and with a black blotch under the eye. The anal fin of the male mosquitofish is elongate and slender, and is modified into a special reproductive organ.

Importance

There is no evidence the pupfish have any appreciable effect on other fishes in the Sea. They are interesting aquarium fish, and small numbers are collected for this purpose.

MOSQUITOFISH, *Gambusia affinis affinis* (Baird and Girard)
(Figure 28)

The mosquitofish, family Poeciliidae, was introduced into the Salto Sea sometime prior to 1929. It is native to the eastern United State but was distributed widely during the early part of this centur to aid in mosquito control. It is common in the fresh waters surrounc ing the Sea, and is often found in the shallow areas, particularl near freshwater inlets.

Recognition Characters

Mosquitofish rarely exceed 1¾ inches in length. The small size rathe uniform tan coloration on back and sides, with tiny black spots, the blac blotch under the eyes, and the single dorsal fin composed of soft ray: set them apart from all other fish in the Sea. The only species wit which they might be confused is the desert pupfish, from which the: differ markedly in coloration.

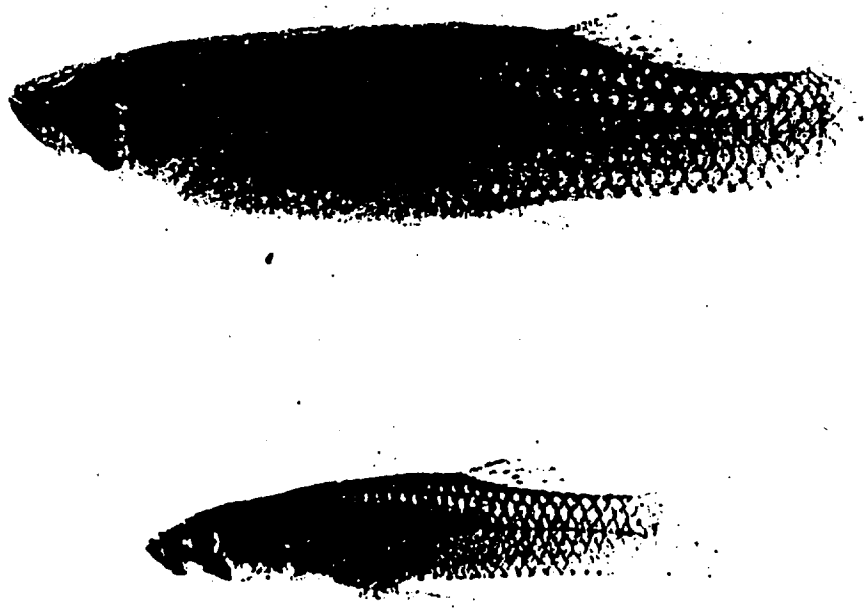

FIGURE 28. The mosquitofish, *Gambusia affinis affinis* (Baird and Girard). Photo by W. J. Baldwin.

Importance

Mosquitofish are never present in sufficient numbers to be important as forage or as competitors. They may be of some value in mosquito control.

STRIPED MULLET, *Mugil cephalus* Linnaeus
(Figure 29)

The striped mullet, family Mugilidae, was at one time abundant in the Salton Sea, and provided both a commercial and a sport fishery. The entire population consisted of mullet which had been spawned in the Gulf of California, and which had reached the Sea via the Colorado River and irrigation laterals. Due to changes in the irrigation laterals in the Imperial Valley, mullet can no longer enter the Salton Sea, and they are now virtually extinct. There is no evidence that they ever spawned in the Sea.

Recognition Characters

Striped mullet reached a large size in the Sea, and fish of 10 to 12 pounds were not uncommon. They are easily recognized by their broad heads; bluegreen backs and silvery sides and bellies, with narrow black stripes along the upper scale rows; and the small first dorsal fin, composed of spines, placed well forward of the second dorsal, composed of soft rays.

Importance

Now virtually extinct and of no importance.

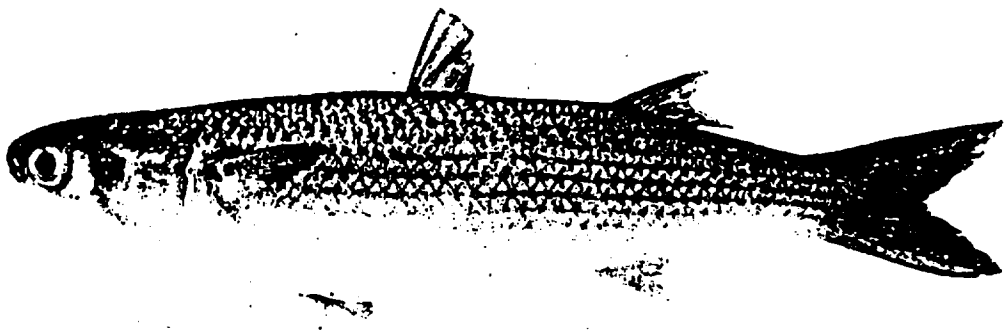

FIGURE 29. The striped mullet, *Mugil cephalus* Linnaeus. California Department of Fish and Game photo.

SARGO, *Anisotremus davidsoni* (Steindachner)
(Figure 30)

The sargo, family Pomadasyidae, has a normal range from Point Conception, California to southern Baja California, and in the upper Gulf of California. In California it may reach 20 inches, but fish longer than 14 inches are rarely taken in the Gulf of California. The large population of sargo now in the Salton Sea was derived from a single

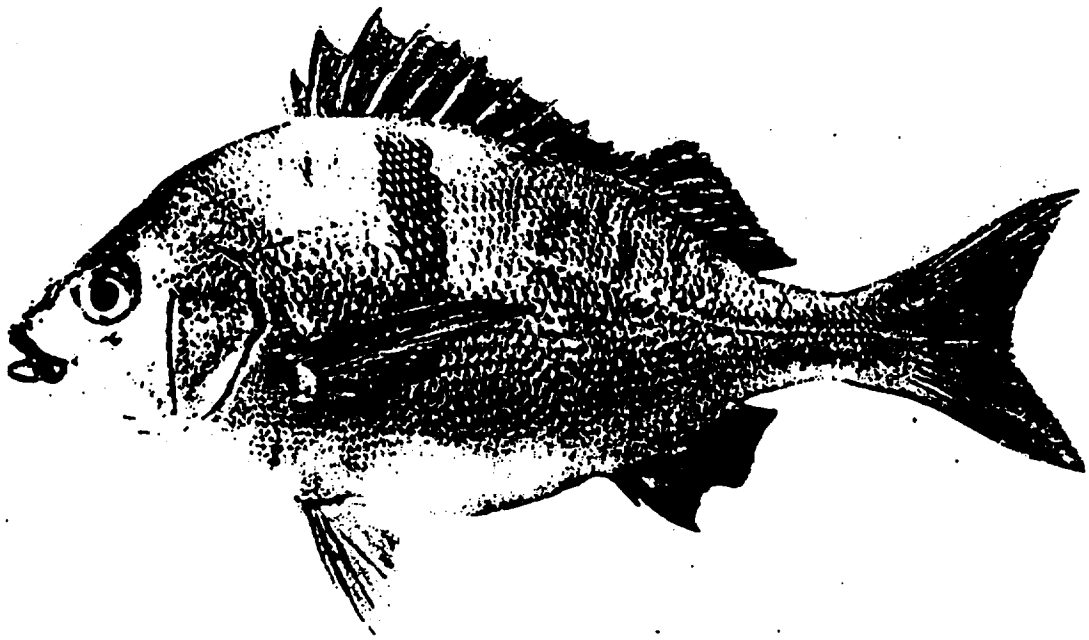

FIGURE 30. The sargo, *Anisotremus davidsoni* (Steindachner). California Department of Fish and Game photo.

plant of 65 fish, made on March 31, 1951 by the California Department of Fish and Game. Unlike the bairdiella, the sargo did not show an explosive early increase in numbers. Only three specimens were taken during the period of study by the Salton Sea Project. The first was taken October 29, 1956, in a gill net set at a depth of 30 feet, one mile off Fish Springs. It was 199 mm standard length, and obviously represented a year-class spawned in the Salton Sea. A second specimen, 91 mm standard length, was taken on November 26, 1956, on the opposite side of the Sea. The only other specimen was a young-of-the-year, 26 mm standard length, taken May 22, 1957, by seining at Fish Springs. These catches indicated the establishment and spawning success of the sargo, but there was no indication of a sizable population. They have increased remarkably in numbers since 1957, and by 1960 had produced an extremely large population supporting a considerable sport fishery. Unfortunately, since the sargo did not show its abundance until after the field study on the Salton Sea was terminated, we have no information on its life history.

Recognition Characters

The size that the sargo will reach in the Salton Sea is not known, but it may be expected to exceed 14 inches. It is easily recognized by its deep body; the strong, spinous first dorsal which is connected to the second dorsal; the three strong spines in the anal fin; and the black bar extending below the fifth to seventh dorsal spines. Very small sargo have two black stripes running laterally along the body, and they do not show the black bar.

Importance

With their great increase in population, the sargo has become an important game and forage fish in the Salton Sea. It well may replace the

bairdiella in importance as forage for the orangemouth corvina. It is a good game fish in its own right, and is an excellent food fish.

Fishing Methods

Sargo readily take almost any kind of bait on moderate-sized hooks. They may be fished from shore or from a boat.

BAIRDIELLA, *Bairdiella icistius* (Jordan and Gilbert)
(Figure 31)

The bairdiella, family Sciaenidae, is native to the Gulf of California, where its is common in shallow and moderate depths. Sixty-seven specimens, taken at San Felipe, Baja California, Mexico, were planted in the Salton Sea in 1950 and 1951. From this modest introduction, their numbers in the Sea increased until millions were present in 1953.

Recognition Characters

The bairdiella is a small, silvery fish, usually less than 10 inches long, and never exceeding 12. It, as well as the two corvinas, has only two spines in the anal fin. The second spine provides the best recognition character, for it is much longer than the anal spine of any other fish in the Sea. When pushed flat against the ventral surface of the body it extends well past the end of the anal fin. In all other species in the Sea, the anal spine is shorter than the anal fin. Rarely, bairdiellas are taken in the Salton Sea with more than two spines. These fish may still be distinguished by the length of the anal spines, however.

Importance

It is chiefly valuable as forage for the corvinas. Because of its small size it is not of much value as a game or food fish, but many are caught incidentally.

FIGURE 31. The bairdiella, *Bairdiella icistius* (Jordan and Gilbert). Photo by Jack W. Schott.

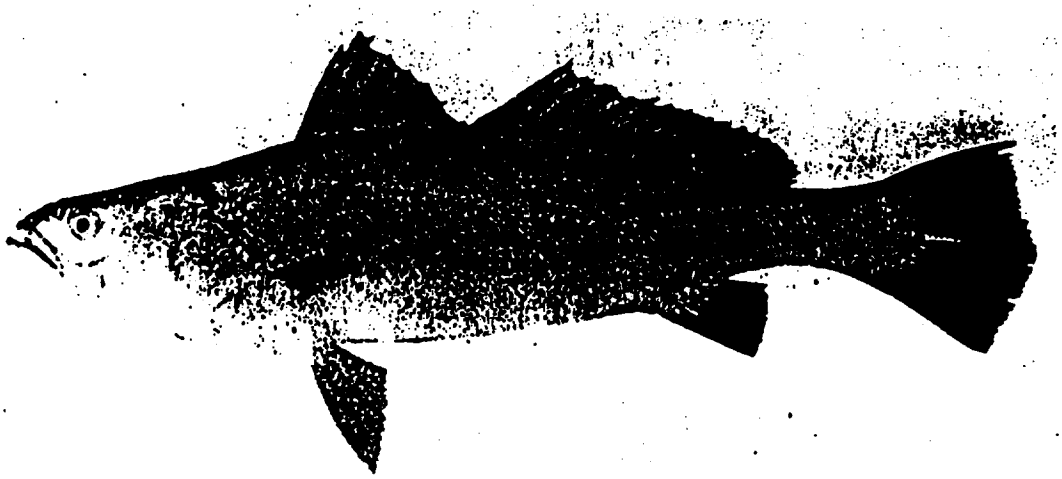

FIGURE 32: The orangemouth corvina, *Cynoscion xanthulus* Jordan and Gilbert. California Department of Fish and Game photo.

ORANGEMOUTH CORVINA, *Cynoscion xanthulus* Jordan and Gilbert (Figure 32)

The orangemouth corvina, family Sciaenidae, has a normal range within the Gulf of California, where it is a well-known and much sought-after game fish. This species was planted in the Salton Sea at various times between 1950 and 1955. It is not known exactly how many were introduced, but the number did not exceed 272. From this small stock, the population has increased to the point where a substantial sport fishery flourishes today. Certainly millions of corvina are present in Salton Sea at this time.

Recognition Characters

The orangemouth corvina is a long, racy fish, with a tan back and silvery flanks. From most fish in the Salton Sea, it can be distinguished by its two anal spines; its large mouth which reaches nearly to a vertical from the back of the eye; its undershot jaw; and its two, almost separated, dorsal fins. It most closely resembles the shortfin corvina, from which it can be distinguished by the shape of the caudal fin and the number of rays in the anal fin. In the orangemouth corvina the middle caudal rays are long, so that the posterior edge of the tail is > shaped. In the shortfin corvina the posterior border of the caudal is straight or forms a weak ∫ shape. In the orangemouth corvina there are 7 to 9 anal rays, while in the shortfin corvina there are 10 or 11.

Importance

The chief game fish in the Salton Sea. Orangemouth corvina reach a large size, a 32-pounder being the largest taken in the Sea. Fall and spring are the best angling seasons, and many anglers take their limits (6 fish) during these times.

Fishing Methods

May be taken with live bait, or with large spoons and plugs, either fishing from shore or from a boat.

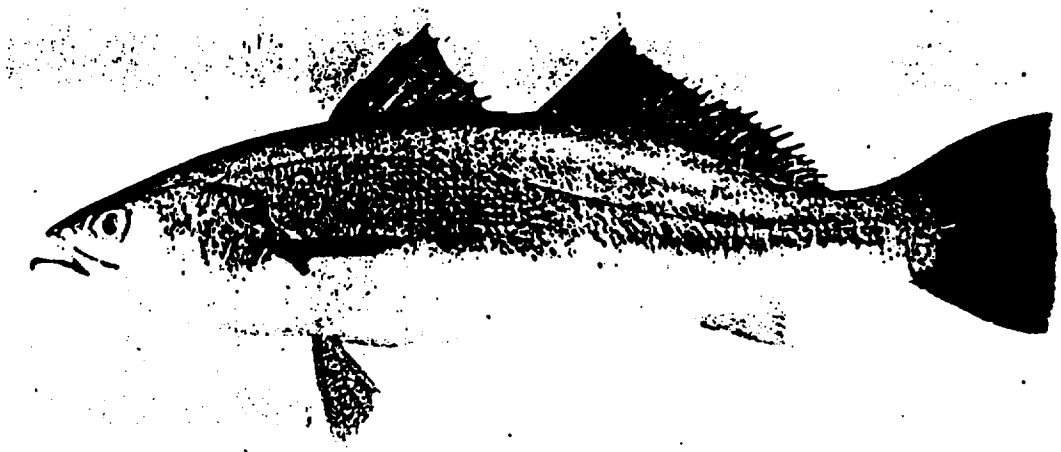

FIGURE 33. The shortfin corvina, *Cynoscion parvipinnis* Ayres. California Department of Fish and Game photo.

SHORTFIN CORVINA, *Cynoscion parvipinnis* Ayres
(Figure 33)

The shortfin corvina, family Sciaenidae, has a normal range from central Baja California to and including the Gulf of California. It was introduced into the Salton Sea by members of the Department of Fish and Game at the same time as the orangemouth corvina in 1950, 1951, and 1953. The fish were brought from San Felipe, Mexico. The number planted was no less than 110, nor more than 310, depending on the corvina planted on March 31, 1951, which were not identified as to species. In addition, plants were made in 1955 and 1956 in a cooperative venture of the University of California and the Department of Fish and Game. A total of 114 was planted in 1955, and 1,545 in 1956. All of these fish were marked.

The shortfin corvina has demonstrated an ability to survive in the Salton Sea, but has never clearly shown any evidence of having spawned there. Eleven fin-clipped individuals have been recovered from the 1955 and 1956 plants. Four of these were caught at least one year after having been planted. Some regeneration of the pelvic fins was observed in five of the fish, though it was very slight in two, consisting of a few twisted rays projecting from the stump. One fish, however, showed almost complete regeneration of the fins, though the rays were twisted and recognizable as having regenerated. Five of the fin-clipped fish also showed injuries to lower or upper rays of the caudal fin, these being bent at the edge or coalesced. Undoubtedly, these injuries were accidentally inflicted either during the netting operations in Mexico or the handling for fin-clipping, or during transportation in tank trucks to the Salton Sea.

Two shortfin corvina which were not fin-clipped were taken in the Salton Sea; one in June 1954 and the other in May 1956. Both might have come from plants made previously.

Recognition Characters

Importance

Probably none, since there is no indication of successful spawning. If spawning should be successful in the future, they would play the same role as the orangemouth corvina.

LONGJAW MUDSUCKER, *Gillichthys mirabilis* Cooper
(Figure 34)

The longjaw mudsucker, family Gobiidae, has a normal range from central California to Magdalena Bay, Baja California, and in the Gulf of California. The Salton Sea population evidently stems from 500 fish planted on November 13, 1930 by the California Department of Fish and Game. They had been secured in San Diego Bay.

The major objective of the research on *Gillichthys* was to evaluate the role they played in the over-all economy of the Salton Sea. Factors that determined distribution and abundance, as well as relationships with other fish were considered. An additional goal, was to ascertain the possibilities of maintaining a mudsucker bait fishery. The location of the Salton Sea between population centers of southern California and the Colorado River fishing areas makes it an ideal site for obtaining mudsuckers.

In order to determine their reproductive potential, samples were collected approximately a month apart beginning in October 1954 at two stations. One was the boat channel at Fish Springs, which was typical habitat for fish in shallow water about the perimeter of the Sea. The second station was a series of shore pools at Salton Sea Beach. These shore pools were extremely variable in such physical factors as salinity, oxygen tension, and temperature.

In the boat channel at Fish Springs, ovary development started in September, but it did not begin until a month later (in October) in the shore pools. Gonadal development reached a peak in the Fish Springs population in late December and spawning started in January. The peak for the shore pool populations occurred in late January and early February. The first spawning in the shore pools occurred in February.

Apparently the January and February spawnings were not highly successful. No larval *Gillichthys* were recovered during this period from either day or night samples taken along the shore at several points, as well as in the shore pools. Some young fish did survive

FIGURE 34. The longjaw mudsucker, *Gillichthys mirabilis* Cooper. California Department of Fish and Game photo.

however, because during subsequent months they were found as juveniles in shallow water.

The small number of mudsuckers produced in January and February probably was not attributable to fewer spawning females, because the conditions of the ovaries indicated that many fish spawned during these months. It seems more probable that the level of zooplankton at that time was too low to support the majority of the larvae. Such zooplankton organisms as rotifers, copepods, and barnacle nauplii were scarce in winter, becoming more abundant in the months that followed. However, the food habits of the early larvae were not studied because of a lack of material previous to April. We may postulate that since zooplankton must play an important role in their diet, a low level of zooplankton may limit the abundance of the larval mudsuckers.

Spawning in the Fish Springs population again reached a peak during late March and early April. The intensity of spawning, as determined by examining the ovaries of the females, was confirmed by a corresponding increase in abundance of larval *Gillichthys*.

By the middle of May, most of the females had spawned and the ovaries of many were again starting to develop. Many of the gonads were, at this time, slightly abormal in appearance. Often large, unspawned eggs had been retained and were being resorbed. Apparently, some females did not release all of their eggs during spawning.

Each female spawned at least twice and perhaps three times per season. A fair idea of the rate of development of the ovaries was determined by following the frequency of a particular stage in succeeding samples after the January spawning. These samples indicated that the interval between spawnings was probably not more than two to three months.

It was found convenient to separate the Salton Sea *Gillichthys* into five different size categories for study: prolarvae; prolarvae to 15 mm; 15 to 25 mm; 25 mm to young adults (about 60 to 70 mm); and adults. The food habits and mode of life together with certain morphological changes constitute the criteria for these divisions.

The prolarvae were seldom taken. They are less than 3.5 mm long and retain the yolk sac. The earliest developmental stage commonly taken was fish larger than prolarvae and shorter than 15 mm. These heavily-pigmented little fish were still pelagic though they lived in quiet, shallow waters along the shore.

At about 15 mm the young mudsuckers descended to the bottom in shallow water, and assumed a mottled coloration. Between 15 and 25 mm, the diet was quite different from that of the slightly larger juveniles. Harpacticoids and punky fly (Heleidae) larvae formed nearly 100 percent of the diet of the 15 mm fish. The relative abundance of this food fell off sharply as the fish approached 25 mm in length. Punky fly larvae were seldom found in fish as large as 30 mm. Free-living nematodes, at times, comprised up to 10 percent of the bulk of the food in a *Gillichthys* 15 to 25 mm long. They were eaten only incidently in fish larger than this. Rarely, fish as large as 80 mm had a few nematodes in their stomachs. These definitely were not parasitic.

In *Gillichthys* as small as 15 mm, *Neanthes* were occasionally found. They became increasingly important in the 23 to 25 mm fish and often

comprised 100 percent of the food in fish as large or larger than 30 mm. In the 30 mm and larger fish, young pupfish were sometimes found.

Juvenile fish from 25 mm to young adults were captured only in very shallow water along the shore and in the lagoons. They are usually heavily barred and the first dorsal fin has a large, black blotch. A large part of their diet was made up of *Ephydra* (brine fly) larvae, and *Trichocorixa*, an aquatic Hemiptera. These insects were especially abundant along the shore and in the lagoons. *Neanthes*, however, was the most important food organism.

The only important food of the adult *Gillichthys* was the pile worm, *Neanthes*. Barnacles were sometimes eaten shell and all. Although a single mudsucker may have made a complete meal of barnacles, they seldom provided more than 5 to 10 percent of the over-all diet of the population.

Ephydra and *Trichocorixa* larvae were often eaten by mudsuckers living near the shore. Due to the small sizes of these insect larvae as compared to the adult *Gillichthys*, they comprised very little of the bulk of the ingested food organisms. They were not important to the adult mudsucker. Desert pupfish and young mudsuckers were the only fish eaten by the mature *Gillichthys*. Their low frequency of occurrence in the stomachs suggested they were not an important food source.

Trapping and netting was done at regular intervals over 24-hour periods. No pattern could be discerned in which *Gillichthys* fed significantly heavier than at any other time. Daylight feeding seemed to be slightly heavier than night feeding.

The *Gillichthys* in the Salton Sea were exceptionally free of parasites. In over 300 preserved fish, only one had an embedded nematode in the lower intestine. In 25 fresh fish, only two parasites were found. These were small monogenetic flukes found on the gills. San Francisco Bay mudsuckers are commonly infested with nematodes in the gut and with monogenetic flukes on the gills. A few Newport Bay mudsuckers were found with ectoparasitic leeches on their heads.

Growth of young *Gillichthys* was rapid. It was fastest during May to August, the hot summer months. By August, the modal size usually had reached about 60 to 80 mm standard length, when they may be considered young adults. Sex is clearly distinguishable by examining the genital papilla. The males grew slightly faster than the females.

Growth tapered off during the winter. In December, the yearlings ranged from about 80 to 115 mm, but growth was very slow after that. A few of the larger fish reached 120 mm by May and all fish spawned at the end of their first year.

The life span was at least two years, maximum size being about 135 to 140 mm standard length (about 5½ inches total length). A preliminary examination of the otoliths, opercles, vertebrae, and hypural plates, failed to reveal more than one annual mark. More sensitive procedures may reveal at least a second annulus. Since growth after the first year was very slow, one would not expect to find a well-separated second annulus.

In only a few places, were mudsuckers abundant in the Salton Sea. They have been taken along all the shores and a few have been trapped in water as deep as 35 feet, two miles offshore. All those taken in deeper

Cover and quiet water appear to be the most important factors determining their distribution in the Salton Sea. Wave action will drive them from cover. They have been found in areas of low salinity, such as in Salton Creek and around Mullet Island. Areas in which the salinity was almost twice that of ocean water also harbored a few. They have been found in lagoons in which the minimum temperature was 35 degrees C. In locations such as the boat channel at Fish Springs in which the oxygen tension drops to less than 2 ml per liter at night, they were able to survive by a combination of behavioral and physiological mechanisms. The fins became engorged with blood, evidently enabling them to undergo cutaneous respiration when in the low oxygen water. At night, many moved up onto the bank into water about six inches deep where the oxygen tension was higher than in the deeper water. This same behavior has been observed in the *Gillichthys* in the lagoons during the hot months.

In the habitats in which *Gillichthys* occurs, there appears to be little competitive overlap with the other fishes. They are not known to eat mosquitofish and bairdiella but desert pupfish are occasionally taken. In areas where *Cyprinodon, Gambusia,* and *Gillichthys* were found together, the abundance of the former appeared not to have been affected.

Recognition Characters

The longjaw mudsucker may reach 5½ inches in length in the Salton Sea. The extremely long upper jaw, reaching to the posterior part of the head in adults; the muddy brown color; the small embedded scales; and pelvic fins joined to form a disc, all separate them from any other species in the Sea.

Importance

They are probably not numerous enough in the Salton Sea to be seriously considered predators on, or competitors with, other fishes. They have value as bait fish, and perhaps the population is large enough to support a small bait fishery. Mudsuckers are one of the best baits for corvina. At certain seasons they were important in the diet of the corvina.

Fishing Methods

May be taken with baited traps.