INVERTEBRATE FAUNA

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INTRODUCTION

The varieties of invertebrate animals which can live in the Salton Sea are limited because the Sea provides a difficult environment. The annual temperature range is extremely wide for a saltwater environment, from 10 to 36 degrees C (50-97 degrees F). Furthermore, the amount of dissolved oxygen is low in summer, and the deeper water becomes anoxic. In addition, the Sea is an odd environment because, although it is a "marine-like" body of water, it is not of marine origin. Its water was virtually fresh as recently as 1916. Although the salinity is nearly the same as in the oceans, the chemical composition is different.

The number of species is further limited by the limited variety of habitats. The beaches, especially those on the west shore, are of fine sand; the only rocky area is around Mullet Island. Most of the bottom is soft sand or silt. There are no visible plants except blue-green algae which form a mat on the bottom in shallow areas. Inundated brush along the shore provides the only place of attachment for larger sessile organisms.

ORGANISMS PRESENT

In the discussion below the invertebrate animals are considered relative to their role in the food cycle of the Sea. Six phyla of invertebrate animals are represented.

Protozoa

Numerous species of the Class Ciliata were common in the decaying organic matter (detritus) and among the blue-green algae which cover much of the bottom. Of the Class Rhizopoda, amoebas and radiolarians have been observed in the algal mat, and about 30 species of foraminifera have been reported by Chirch (Rogers, 1949) and by Arnal (1957). Bottom-dwelling protozoans are available to those organisms which feed on the bottom; however, the mass represented by protozoans was small, relative to total algae and detritus.

Rotifera

One rotifer, *Brachionus plicatilis*, was an important part of the zooplankton in summer and was available to organisms which get their food by filtering plankton from the water. However, in the observed food chain there was no large filter-feeding animal so the rotifers were not utilized directly; the majority of them would die, settle, and add to the bottom detritus.

Bryozoa

Two species of Bryozoa identified by Soule (1957) were *Nolella blakei* and *Victoriella pavida*. These colonial animals form a moss-like growth on solid objects. They were not sufficiently numerous to be significant in the food cycle, and are mentioned only because the Salton Sea specimens were the first of these species reported on the west coast.

Nematoda

Nematodes occurred in the mat of algae and detritus on the bottom. They have been identified to the genus *Spilophorella*. Although present in fairly large numbers, they are so small, and were so intermeshed in the bottom material that their small mass can be considered a part of the detritus available to bottom-feeding organisms.

Annelida

The one species present, *Neanthes succinea*, was probably introduced in 1930 when a few "pile worms" were included in material planted by the California Department of Fish and Game. *Neanthes* was the most important food for fish in the Sea. It is a detritus-feeding worm which spends most of its life in burrows at the bottom and among masses of barnacles. The sexual stage, one to three inches long, swims to the surface to spawn, and is easy prey for carnivorous fish.

Arthropoda——Class Crustacea.

Ostracoda

Bottom samples contained some unidentified ostracods whose small number made them insignificant in the food cycle except as part of the material available to bottom-feeding organisms.

Copepoda

An unidentified harpacticoid copepod was present in small numbers near short. The only numerically important copepod was *Cyclops dimorphus*, which was in the plankton in summer and fall. It was so numerous in summer that it could support a sizable population of filter-feeding organisms, but, it seemed to be eaten only by the young bairdiella and by the threadfin shad.

Cirripedia

Barnacles, *Balanus amphitrite* Darwin, were first observed in the Sea about 1944 (Cockerell, 1945). The variety there was classed as a subspecies, *B. a. saltonensis*, by Rogers (1949). *Balanus* was probably introduced from the California coast or from the Gulf of California because it most closely resembles *B. a. inexpectus* (Pilsbry, 1916) found in these two areas. Since its introduction, it has reproduced rapidly and spread to all parts of the Sea. It seems to have become smaller and to have undergone change in shell structure so that compared to the parent species, the sides are more nearly parallel and the aperture is about the same size as the base. It may be that this characteristic is due to crowding, because when reared in the laboratory, the shape is conical, similar to the form of *B. a. inexpectus*. The shell of the *B. a. saltonensis* is lighter (thinner), but this may be due to its rapid growth under the high temperatures of the Sea. The numbers in the plankton were greatest in spring and fall. There were usually more near shore than offshore. There were so few places for adults to attach that it was taken three miles from shore (April 22, 1955). Near shore the maximum observed was 644 per liter (April 30, 1956).

The cyprids settled on any submerged hard surface, including each other; they formed large clumps around even small objects. Since surfaces for attachment were limited (because most of the bottom was soft mud), the barnacle was restricted to a few rocky areas, to areas of submerged brush and debris near shore, and to the few pilings and docks in the Sea.

Since any solid object in the water seemed to become completely covered with barnacles within a few days, an attempt was made to determine the rate of settlement. Glass microscope slides were suspended for 10-, 30-, and 90-day periods at various locations. Few settled from November through February. They began to settle in large numbers in March 1955 and continued through October.

There was a rapid increase in the number that settled during March (Table 15). The data for April would seem to indicate a decrease in the number settling; however, since all available space was occupied in fewer than 10 days, the decrease in number per unit area was probably due to lack of surface area brought about by increased rate of growth. On a few occasions, slides were exposed for a 24-hour period. The highest rate of settlement on these was on August 20, 1955 (which was not the period of maximum settlement) when 200 barnacles settled per square inch (410,000/sq. meter/day).

The rate of growth was estimated from the average size of the 10 largest barnacles on the glass slides submerged for 30 days (Table 16). The maximum rate of growth was in summer when, during July, Au-

TABLE 15
Settling Rates and Maximum Growth for Barnacles in the Salton Sea During March and April, 1955

Date	Total Days	Number Settling per m^2/Day	Average Diameter in mm of 10 Largest
February 28 to March 13	13	0.246	0.59
March 13 to March 23	10	15.4	0.88
March 23 to April 1	9	139.+	1.07
April 1 to April 13	12	121.+	1.63
April 13 to April 27	14	68.5+	2.07
April 23 to May 4	12	89.6+	2.18

TABLE 16
Average Size of the 10 Largest Barnacles on Glass Slides Submerged in the Salton Sea for 30 Days, 1955-1956

Month	Maximum Basal Diameter in mm	Month	Maximum Basal Diameter in mm
March	2.0	September	8.5
April	5.0	October	5.0
May	5.5	November	less than 1.0
June	6.25	December	less than 1.0
July	8.5	January	less than 1.0
August	9.0	February	1.0

gust, and September, the basal diameter attained in 30 days was about 9 mm (⅜ inch). During the coldest part of the year, the growth rate was less than one-tenth that of summer.

The larger barnacles on slides exposed for 30 days during August and September contained well-developed larvae, indicating that growth to sexual maturity took place in less than a month.

The great numbers and the rapid growth of *Balanus* made them significant in the economy of the Sea. The shells were washed up and deposited on some of the beaches where they were crushed by wave action into a coarse "sand." In some regions, this layer was several feet thick and the "sand" beaches were suitable for recreational use in areas that were formerly muddy.

The adult barnacles, although thin-shelled, were only occasionally eaten by any of the fishes in the Sea. Barlow (unpublished data) found that barnacles made up about five percent of the diet of the mudsucker.

TABLE 17

List of Known Introductions of Invertebrates Into the Salton Sea *

Date	Number	Species	Group Name	Where Acquired
13 Nov. 1930	"a few"	*Neanthes succinea*	polychaete worm	San Diego Bay
	15,000	*Callianassa* sp.	ghost shrimp	San Diego Bay
12 May 1950	25?	*Callinectes bellicosus*	crab	San Felipe
	10?	*Loligo* sp.	squid	San Felipe
14 Dec. 1950	6	*Callinectes bellicosus*	crab	San Felipe
15 Dec. 1950	12	*Callinectes bellicosus*	crab	San Felipe
28 Mar. 1951	75	*Callinectes bellicosus*	crab	San Felipe
	15	*Loligo* sp.	squid	San Felipe
	5	*Penaeus stylirostris*	shrimp	San Felipe
31 Mar. 1951	10	*Penaeus stylirostris*	shrimp	San Felipe
	5	*Loligo* sp.	squid	San Felipe
4 May 1953	10,000	Kumamoto oysters	oyster	Japan
	100	*Ostrea lurida*	oyster	Anaheim Slough
	1,000	*Protothaca staminea*	clam	Anaheim Slough
	5,000	*Mytilus edulis*	mussel	Anaheim Slough
	250	*Chione fluctifraga*	clam	Anaheim Slough
16 May 1953	3,500	*Tapes semidecussata*	clam	San Francisco Bay
	500	*Protothaca grata*	clam	San Felipe
	12	*Mytella guyanensis*	mussel	San Felipe
Aug. 1953	10-gal	{ *Mytilus edulis* (95%)	mussel	Anaheim Slough
		{ *Mytilus californianus* (5%)	mussel	Anaheim Slough
10 Apr. 1955	450	{ *Archaeomysis maculata*	mysid	San Felipe
		{ *Mysidopsis californica*	mysid	San Felipe
18 Nov. 1955	3,000	{ *Archaeomysis maculata*	mysid	San Felipe
		{ *Mysidopsis californica*	mysid	San Felipe
9 Aug. 1956	194	*Capitella capitata*	polychaete worm	Culture from Dr. D. Reish
10 Aug. 1956	15,000	*Capitella capitata*	polychaete worm	Culture from Dr. D. Reish
13 Aug. 1956	155	*Capitella capitata*	polychaete worm	Culture from Dr. D. Reish
5 Feb. 1957	?	*Capitella capitata*	polychaete worm	Texas
	?	*Capitella* sp.	polychaete worm	Texas
	?	*Eteone alba*	polychaete worm	Texas
	?	*Marphysa sanguinea*	eunicid tube-worm	Texas
	?	*Melinna maculata*	polychaete worm	Texas
	?	*Anomalocardia cuneimeris*	clam	Texas
	?	*Cerithidea aguayoi*	snail	Texas
	?	*Modiolus aborescens*	mussel	Texas
	?	*Mulinia lateralis*	clam	Texas
	?	*Tellina tampaensis*	clam	Texas
	?	*Crepidula* sp.	limpet	Texas
	?	*Mytilus* sp.	mussel	Texas
	?	*Spisula* sp.	clam	Texas

The larvae would be available to filter-feeding organisms, but it is oubtful that they are a significant source of fish food. Small quantities were eaten by the fry of bairdiella. The Salton Sea barnacle is robably detrimental to the food cycle leading to the corvina, because *'alanus* expends nutriment which might otherwise be available to *'canthes,* an important fish food.

INTRODUCTIONS

Various invertebrate animals have been introduced into the Sea to rovide food for fish populations, or to provide food directly for man Table 17). The bivalves (mussels, oysters, and clams) were planted rith the hope of providing a recreational fishery for these desirable ood items. The other species were introduced as fish food, or acci- 'ently with other organisms. The plants prior to 1955 were made by he California Department of Fish and Game. The introductions of ıysids and polychaete worm *Capitella* in 1955 and 1956 were made by he project personnel. On February 5, 1957, an unknown number of ıany species of invertebrates was introduced unintentionally with ılants of shoal grass, *Diplanthera wighti,* from Texas. The shoal grass ras planted by the California Department of Fish and Game to pro- ide food for wildfowl. Other invertebrates undoubtedly were intro- luced unintentionally during fish transplants, or by boats and other quipment transferred from the coasts of California or from the Gulf f California.