

## DIVERSITY IN FEEDING BY BRANDT'S CORMORANT NEAR SAN DIEGO<sup>1</sup>

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**Brandt's cormorants feed on diverse assemblages of fish species, in a wide variety of habitats. They feed in dense kelp beds and in open water; in midwater; on the bottom, sometimes rather deep; and near the surface. Each day the birds move out en masse from fixed roosts. Mass flights to different feeding areas may be abruptly alternated on a time scale of a few days. This species, like some other cormorants, sometimes feeds singly or in small groups, often mixed with other bird species; but at times feeds in huge compact rafts of seemingly frantic birds, all of this species. These rafts move, apparently following schools of fish, by the repeated flight of groups of birds from the trailing edge to the very front of the raft. Both large and small fish are consumed, most of which are of limited commercial significance. Cormorants are very accomplished underwater swimmers, making use of their feet only.**

### INTRODUCTION

Studies carried out over the past 25 years in the vicinity of San Diego, California, indicate sharp diversity in the feeding habitats and food of Brandt's cormorant, *Phalacrocorax penicillatus* (Brandt). Though incidental and intermittent, the field observations and food analyses show that this cormorant feeds effectively in several distinct habitats, wherein different assemblages of fish species are consumed.

The vernacular names of fishes follow "A List of Common and Scientific Names of Fishes from the United States and Canada," American Fisheries Society Special Publication No. 2, 1960, in conformity with the editorial policy of this journal.

The diversity in feeding behavior of Brandt's cormorants was impressed on one of us (C.L.H.) in 1944-48, when he almost daily watched the movements of this species from and to their crowded roost on the nearly vertical cliffs between and above the famed La Jolla Caves (Williams, 1942; Martini, 1966). Most of the observing was done with binoculars from Scripps Institution, approximately 1 mile north of the Caves, on the coast in the northern part of San Diego.

In those happy years, before the swarming activities of man and the alarming increase in the pollution of coastal waters by pesticides and other pollutants, approximately 2,000 cormorants, about 99% Brandt's and 1% double-crested, *Phalacrocorax auritus albociliatus* Ridgway, occupied this rookery. In this very picturesque habitat, they provided a prime attraction that has dwindled almost to the level of disappearance. Strikingly marked reduction was observed as early as May 1961, when the cliffs were utilized largely by western gulls, *Larus occidentalis* Audubon. Brandt's cormorants soon returned in moderate numbers, with some seasonal fluctuations in comparison with the other

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species of cormorants and other sea birds, as noted for 1962 by Martini (1966), who gave a maximum estimate of about 400 Brandt's cormorants on the Caves cliff.

In the 1940's, Brandt's cormorants crowded onto every available ledge to which a bird could cling on the nearly vertical cliff face. Considerable numbers nested, though there were not nearly enough suitable ledges to provide nesting sites for all. That many did nest here seems an exception to the rule stated by Jared Verner (*in* Palmer, 1962) that this species nests "almost always on sloping (not precipitous) surfaces." As Williams (1942) noted, this sheer-cliff nesting at La Jolla on an exceptional mainland site contrasts with nesting on a less steep base on inshore rocks. On the La Jolla cliff there is sloping ground, with low bushes, on the rim of the Caves cliff ; but, as noted by Michael (1935) and Martini (1966), this area was monopolized by the much smaller population of double-crested cormorants. The two species foraged, roosted, and nested separately. We have observed similar habitat segregation on the cliffs of northwestern Baja California. There is, in general, a contrast in the feeding areas along the Baja California coast : Brandt's cormorants feed mostly along the more rugged coast with stronger surf ; double-crested cormorants more in bays, lagoons, and the more protected open coast.

In recent years, double-crested cormorants have come to roost on power lines crossing the San Diego River floodway just south of Mission Bay in San Diego. Earlier, double-crested cormorants in San Francisco Bay adopted the same bizarre roosting habit (Bartholomew, 1943). No Brandt's cormorants seem to have acquired this habit.

### FEEDING FLIGHTS

The Brandt's cormorants returned before dark to the La Jolla Caves cliff from their daily feeding forays, singly or in generally small groups, filling before dark every available little ledge, commonly with considerable aggressive behavior (Williams, 1942). At a very regular time in the morning, varying somewhat with degree of overcast, the birds took off for their feeding areas ; at first usually singly or in small groups, but soon in rapid procession. Areas of the cliff first struck by the early morning sunlight were usually the first to be vacated. Groups took off by swooping outward and downward nearly to the ocean surface. They then promptly formed into single files or V's.

Ordinarily for several successive days the Brandt's cormorants all flew outward, then westward to off Point La Jolla where vast beds of giant kelp, *Macrocystis pyrifera* (Linnaeus), then flourished, providing a rich supply of fish (Limbaugh, 1955; Quast, 1968). Here the feeding rafts tended to be broken up, probably because the surface canopy of kelp was in large, very dense patches and feeding by the birds was largely confined to openings in the kelp bed.

Occasionally the whole colony of birds flew to the outer part of La Jolla Bay, where, in clear view from Scripps Institution, they accumulated in a huge, dense feeding raft of excessively active birds, seemingly frantic in their diving, surfacing, and splashing—much like the activity described by Bartholomew (1942) for the double-crested cormorant in San Francisco Bay. In La Jolla Bay the whole raft kept moving in one direction, apparently following a school of fish. The progression

was accomplished not by a mass movement of the whole raft, but by groups of rear stragglers almost continuously taking off to fly entirely over the whole mass to alight directly in front of the leading edge, seemingly in the midst of the fish school, wherein they immediately started fishing. In this way, the birds in the least favorable fishing spot suddenly attained the prime position, very soon to be demoted into second place when the next flight landed in front of them. In this feeding area, it is almost certain that such schooling fish as anchovies or sardines were being consumed—species quite different from those in the kelp bed or in the other feeding areas now to be described.

After heading unerringly for several successive days into the kelp beds, the entire colony of the La Jolla Caves cliff would, without any apparent stimulus or hesitation, head due north to continue up the straight coastline to feeding grounds off the open, sandy shore, at various places from near Del Mar to near Oceanside : a round trip of roughly 10 to 50 miles. The birds in this area fed on fishes that characteristically live flush on the bare sandy bottom, well beyond the tidal zone and out to depths of probably 50 meters. Here the fish fauna (Ford, 1965) is quite distinct from that of the midwater habitat in the underwater forests of kelp—or from that of the near-surface waters where the rafting behavior was noted. Often for several successive days the entire colony of Brandt's cormorants unhesitatingly took off for the northern grounds, before abruptly reverting, again for no obvious reason, to flying the short distance westward to the kelp beds. Such mass behavior poses a real problem to behaviorists.

On the northward flight, the vanguard would proceed in small files, close to the surface, about 2,000 meters offshore. As the numbers rapidly built up, some of the files became V-shaped, and some occasionally overlapped. The regularity in filing northward made it possible to make a rather precise count (about 2,000) of the entire colony, from the cliff at Scripps Institution. In the return movement, the birds were much more scattered, in time as well as in space. They generally flew close to the surface ; but as they approached the cliff, especially in foggy weather, the entire file of birds would occasionally rise in the form of a progressive wave to a height of about 10 meters, as though to look ahead.

From a roost on a cliff on the ocean side of Point Loma, also in San Diego, Brandt's cormorants have been seen moving out toward feeding grounds either in the adjacent kelp bed, where one bird containing typical kelp fishes was shot, or into San Diego Bay, where it is presumed food was taken, probably representing still another assemblage of species.

#### KELP-BED FEEDERS

Eight food-containing Brandt's cormorants, six from the La Jolla kelp bed and one each from the kelp beds off Point Loma and south of Islas Los Coronados (Table 1), were assumed to have fed in the kelp beds. Their stomachs contained fishes that characteristically live in midwater, often almost exclusively among the fronds of *Macrocystis* (Limbaugh, 1955; Quast, 1968). These 8 birds contained 33 fish specimens representing 5 species in as many genera and in 4 families, as follows :

Señorita, *Oxyjulis californica* (Gunther), family Labridae (wrasses), one of the dominant species in the kelp-bed community : 17 from near La Jolla, 3 from near Islas Los Coronados, 1 from off Point Loma.

Blacksmith, *Chromis punctipinnis* (Cooper), family Pomacentridae (damsel-fishes), abundant in the kelp : 5 from near La Jolla.

Kelp perch, *Brachyistius frenatus* Gill, family Embiotocidae (viviparous perches), another fish abundant in the kelp beds (Hubbs and Hubbs, 1954) and essentially endemic to this habitat : 3, 40-50 mm SL, from near Islas Los Coronados, 2 from off Point Loma.

White seaperch, *Phanerodon furcatus* Girard, family Embiotocidae, rather common in kelp and other inshore habitats: 1, from near La Jolla.

Vermillion rockfish, *Sebastes miniatus* (Jordan and Gilbert), family Scorpaenidae (scorpionfishes), one of the few rockfishes that swims off the bottom, occasionally living in the kelp, especially when young : 1 young, 69 mm SL, from near Islas Los Coronados.

**TABLE 1**  
**Food of Individual Brandt's Cormorants, *Phalacrocorax penicillatus***

Presumed habitat of feeding Where and when collected	Sex of bird	Fish species (no.)	Vol. (ml)
In or near beds of giant kelp ( <i>Macrocystis</i> ) Kelp bed 1 mi. off La Jolla, IV:28:52	M	<i>Chromis punctipinnis</i> (1) <i>Oxyjulis californica</i> (4)	50
Outside kelp bed off La Jolla Caves, V:8:52	M	<i>Phanerodon atripes</i> (1) <i>Oxyjulis californica</i> (4)	110 30
1.5 mi. off La Jolla Caves, flying over kelp bed, V:30:52	M	<i>Chromis punctipinnis</i> (1)	140
La Jolla Caves area, VI:2:52	M	<i>Chromis punctipinnis</i> (1)	60
Off La Jolla Caves, VI:2:52	M	<i>Chromis punctipinnis</i> (2)	--
	F	<i>Oxyjulis californica</i> (9)	40
Off Point Loma, 1:25:55	M	<i>Brachyistius frenatus</i> (2) <i>Oxyjulis californica</i> (1)	-- 4.5
1.5 mi. S. of South Island, Islas Los Coro- nados, VIII:4:69	F	<i>Brachyistius frenatus</i> (3) <i>Oxyjulis californica</i> (3) <i>Sebastes miniatus</i> (1)	8.0 5.6
Sandy bottom off beach		In gular pouch: <i>Citharichthys stigmaeus</i> (3)	ca. 100
Off Scripps Pier, flying S. toward roost at La Jolla Caves, VI:2:52		In stomach: <i>Chitonotus pugetensis</i> (1) <i>Citharichthys stigmaeus</i> (8) <i>Xystreureys liolepis</i> (1) <i>Citharichthys stigmaeus</i> (11) <i>Pleuronichthys decurrens</i> (1)	ca. 150 160
Miscellaneous material Middle Rock, Islas Los Coronados, B. C., Mexico, X:28:52	F	<i>Atherinopsis californiensis</i> (1) <i>Atherinops affinis?</i> (2) <i>Chromis punctipinnis</i> (1) <i>Brachyistius frenatus</i> (1) <i>Trachurus symmetricus</i> (3) <i>Heterostichus rostratus</i> (1) <i>Embiotoca</i> sp. (1) <i>Oxyjulis californica</i> (1)	460 11.0 2.0 19.3 40 69 3.0
0.5 mi. E. of S. end of South Island, Islas Los Coronados, IX:14:69			

Certain fish species (and various crustaceans and other invertebrates) that are highly characteristic of the *Macrocystis* beds and abound there were notably absent in food samples of the Brandt's cormorants that had been feeding in the kelp. These apparently shunned or overlooked animals are concealingly colored and live on the kelp or close among the fronds. In addition, many are hard and/or spiny. The fishes in this cryptic category are kelp pipefish, *Syngnathus californiensis* Storer ;

kelp clingfish, *Rimicola muscarum* (Meek and Pierson) ; striped kelpfish, *Gibbonsia metzi* Hubbs; giant kelpfish, *Heterostichus rostratus* Girard (Hubbs, 1920) ; and kelp gunnel, *Ulvicola sanctaerosae* Gilbert and Starks. A giant kelpfish included in the food of one cormorant was probably taken in red algae. All of these species are taken commonly by the kelp harvesters, which utilize the surface canopy of the kelp, though none are commonly visible by scuba diving or from research submersibles operating in the kelp. The circumstances seem to imply that fishing cormorants rely primarily on vision, and feed particularly on fishes in free motion.

### SAND-BOTTOM FEEDERS

Two Brandt's cormorants containing a different fish assemblage were collected off Scripps Institution Pier as they were returning from the north toward the La Jolla Caves roost. Because the 25 fish specimens taken in these birds represent species characteristic of the sand-bottom habitat, the birds are assumed to have fed off the sandy beaches to the northward. Four species in as many genera and in three families comprised the food of these two birds:

Speckled sanddab, *Citharichthys stigmaeus* Jordan and Gilbert, family Bothidae (left-eyed flounders), the dominant fish in this habitat, at depths inside the 50-meter contour (Ford, 1965) : 22.

Fantail sole, *Xystreureys liolepis* Jordan and Gilbert, family Bothidae: 1.

Chirflin turbot, *Pleuronichthys decurrens* Jordan and Gilbert, family Pleuronectidae (right-eyed flounders) : 1, young.

Roughback sculpin, *Chitonotus pugetensis* (Steindachner), family Cottidae (sculpins) : 1.

### MISCELLANEOUS FEEDERS

Somewhat different and varying feeding habitats, and assemblages of fish species consumed, are represented by two collections taken close to Islas Los Coronados.

One of two Brandt's cormorants taken close to "Middle Rock," the smaller of the two islets between the two main Islas Los Coronados, just south of the international border, contained food. It had obviously been feeding near the surface, where the atherines eaten normally swim. Three specimens, probably of two species, had been eaten :

Jacksmelt, *Atherinopsis californiensis* Girard, family Atherinidae (silversides), a large species: 1 adult.

Topsmelt, *Atherinops affinis* (Ayres), family Atherinidae, a medium-sized species: 2, each about 5 inches long (identification not fully ascertained).

Three of four specimens of Brandt's cormorant taken about 0.5 mile east of the south end of the south island of Islas Los Coronados contained food. Only a few stipes of *Macrocystis* were seen growing here, but some of the birds may have fed in the denser kelp that extends southward from the island. Some fish species commonest in the kelp beds (as noted above) were included, but may have been taken away from the kelp. One open-water species, the jack mackerel, was included, along with a seaperch that is commonest elsewhere (see below). Each bird had eaten two species, of different families :

(1) Blacksmith, *Chromis punctipinnis*, 1 nearly complete, half-grown fish; and kelp perch, *Brachyistius frenatus*, tail end of one, partly digested.

(2) Jack mackerel, *Trachurus symmetricus* (Ayres), family Carangidae, 3 small examples, partial to whole ; and 1 giant kelpfish, *Heterostichus rostratus*, a medium-

sized example of this relatively large member of the Clinidae, in the uniform red-brown phase usually found in red algae on the bottom in moderate depths.

(3) Seaperch, *Embiotoca* sp. (probably distinct from *E. jacksoni*), family Embiotocidae, taken in whole and fresh condition beside the shot bird, almost certainly regurgitated, in the reddish phase developed in relatively deep, hard-bottom, open-coast water; and señorita, *Oxyjulis californica*, tail end of one in fresh condition.

Of the Brandt's cormorants shot for food study, only five, four from Islas Los Coronados and one from the La Jolla kelp beds, contained no food.

#### PUBLISHED ACCOUNTS OF FOOD OF BRANDT'S CORMORANT

Prior determinations of the food of this species of cormorant have been summarized by A. W. Schorger (*in* Palmer, 1962), as follows: "Food largely fishes of no commercial value; also crustaceans," but the fish species identified are Pacific herring, *Clupea pallasii* Valenciennes; cabezon, *Scorpaenichthys marmoratus* (Ayres); and the bocaccio, *Sebastes paucispinis* Ayres, all of some commercial significance. However, the fishes we found that had been eaten were predominantly of minor economic importance. Schorger also reported one crab and some shrimp as food items, but no invertebrate appeared in any of the birds we examined. Gabrielson and Jewett (1940) took a strong stand favoring the conservation of Brandt's cormorant in Oregon, indicating that its food was primarily "trash fish," but gave little solid evidence on its food and economic significance.

Martini (1966) has greatly increased the list of fishes that can be regarded with very high probability as items in the diet of the Brandt's cormorant. These comprise most of the species identified from otoliths in the regurgitated pellets ("Gewöller") of western gulls, *Larus occidentalis*, found on the rocky shore in the immediate vicinity of the La Jolla Caves cliffs, where the Brandt's cormorants roost and often associate with the western gulls. Otoliths are highly resistant and highly distinctive structures. As Martini suggested, it may be assumed that the vast majority of the fish species listed had been caught by Brandt's cormorants. Only a few of the species could conceivably have been captured by the western gull, for they live at depths below those available to a feeding gull. Some of the species, notably Pacific hake, *Merluccius productus* (Ayres), Pacific sanddab, *Citharichthys sordidus* (Girard), pink seaperch, *Zalembeius rosaceus* (Jordan and Gilbert), shortbelly rockfish, *Sebastes jordani* Gilbert, sculpin, *Icelinus* sp., and bluespot goby, *Coryphopterus nicholsii* (Bean), probably were taken at depths of 20 to 50 meters, or more. The gulls may have robbed the cormorants either on the joint feeding grounds or on the cliffs, or may have picked up the fish, or even isolated otoliths, on the ledges. The other species of cormorants are much fewer on the cliffs and are less closely associated with the gulls. No other fish-eating birds are likely to have contributed the otoliths to the gulls. An occasional fish may have been picked up on the beach by a gull, but the fish species attributed to the Brandt's cormorant in the following list are very seldom washed ashore. Seasonally, as Martini (1966) noted, Heermann's gulls, *Larus heermanni* Cassin, occupy the same area near the Caves as the western gulls, but he indicated that this species left no pellets here.

In the list below, species indicated in parentheses by *P* are attributable to original capture, in very high probability, by the Brandt's cormorant; those listed as *L* or *P* either to the western gull or this cormorant; a few are attributed to *P*, possibly *L*. The relative numbers by species of fish are : *P*, 17; *P*, possibly *L*, 3; *P* or *L*, 5. By numbers of otoliths (excluding 39 not identified), the ratios are *P*, 402; *P*, possibly *L*, 18; *P* or *L*, 78.

It appears that the majority of the fishes reported by Martini to have been eaten by western gulls in this area originally had been caught by Brandt's cormorants. Most, perhaps all, of the invertebrate food found by Martini in the castings of the western gull, consisting predominantly of goose barnacles, *Mitella polymerus* (= *Pollicipes polymerus* Sowerby), with some mollusks and occasionally crustaceans and echinoderms, as well as refuse, may be attributed to the gulls alone. Goose barnacles also predominated in western gull pellets spewed on Scripps Pier.

*Fishes Represented by Otoliths in Castings of Western Gulls near  
La Jolla Caves Cliff, as Listed by Martini (1966)*

The figure listed after each species represents the number of otoliths (all sagittae, except for 4 lapillae attributed to an unidentified embiotocid). The nomenclature of a few species is here modified. Species marked with initial asterisk are not included in our food studies.

Engraulididae (anchovies)

\*Anchovy, *Anchoa* sp., probably slough anchovy, *A. delicatissima* (Girard) : 1 (*L* or *P*).

\*Northern anchovy, *Engraulis mordax* Girard : 53 (*L* or *P*).

Merlucciidae (hakes)

\*Pacific hake, *Merluccius productus* (Ayres) : 16 (*P*).

Bothidae (left-eyed flounders)

\*Pacific sanddab, *Citharichthys sordidus* (Girard) : 4 (*P*).

Speckled sanddab, *Citharichthys stigmaeus* Jordan and Gilbert: 11 (*P*).

*C. sordidus* or *C. stigmaeus*: 9 (*P*).

Serranidae (sea basses)

\*Bass, *Paralabrax* sp., perhaps spotted bass, *P. maculatofasciatus* (Steindachner) : 1 (*P*).

Atherinidae (silversides)

\*Grunion, *Leuresthes tenuis* (Ayres) : 10 (*L* or *P*).

Jacksmelt, *Atherinopsis californiensis* Girard : 1 (*L* or *P*).

Topsmelt, *Atherinops affinis* (Ayres) : 13 (*L* or *P*).

Haemulidae (grunts)

\*Sargo, *Anisotremus davidsonii* (Steindachner) : 1 (*P*).

Sciaenidae (croakers)

\*White croaker, *Genyonemus lineatus* (Ayres) : 6 (*P*, possibly *L*).

Embiotocidae (viviparous perches)

\*Walleye surfperch, *Hyperprosopon argenteum* Gibbons : 7 (*P*, possibly *L*).

Black seaperch (ocean representative), *Embiotoca* sp.: 93 (*P*).

White seaperch, *Phanerodon furcatus* Girard: 144 (*P*).

\*Pile perch, *Damalichthys vacca* Girard?: 13 (*P*).

\*Rubberlip seaperch, *Rhacochilus towotes* Agassiz : 4 (*P*).

\*Pink seaperch, *Zalemibus rosaceus* (Jordan and Gilbert) : 4 (*P*).

\*Shiner seaperch, *Cymatogaster aggregata* Gibbons (presumably the typical mainland subspecies) : 5 (*P*, possibly *L*).

Unidentified embiotocid lapillae, with sagittae of *Embiotoca* sp. and *Phanerodon furcatus*: 4 (*P*).

Scorpaenidae (scorpionfishes)

\*Shortbelly rockfish, *Sebastes jordani* Gilbert : 5 (*P*).

Cottidae (sculpins)

\*Sculpin, *Icelinus* sp. (probably *I. tenuis* or *I. quadriseriatus*) : 2 (*P*).

## Gobiidae (gobies)

\* Bluespot goby, *Coryphopterus nicholsii* (Bean) : 4 (P).

## Batrachoididae (toadfishes)

\* Plainfin midshipman, *Porichthys notatus* Girard : 50 (P).

\* Specklefin midshipman, *Porichthys myriaster* Hubbs and Schultz : 3 (P).

## Ophidiidae (cuskeels)

\* Basketweave cuskeel, *Otophidium scrip psi* Hubbs : 22 (P).

\* Spotted cuskeel, *Chilara taylori* (Girard) : 12 (P).

## SUPPLEMENTARY OBSERVATIONS

According to the preceding data, Brandt's cormorant has been indicated with certainty, or high probability, to feed in the San Diego area on 35 species of fish that we class in 31 genera and 18 families. These represent a wide variety of the benthic and nektonic fishes that inhabit the littoral waters of the region, on and over the shallower part of the continental shelf. Extended observations on birds during Marine Vertebrate Cruises of Scripps Institution off southern California and Baja California at various seasons indicate that cormorants ordinarily feed close to shore and are very seldom seen beyond the continental shelf. Only a few individuals of this species (and of the double-crested cormorant) occur on Isla de Guadalupe, the oceanic island off Baja California, despite the fact that small fishes abound around the shores of this island.

In La Jolla Bay, as elsewhere, Brandt's cormorants were seen at times feeding in small groups or even singly, as well as in large groups (as described above). Very often they fed in company with gulls, pelicans, and other birds. Occasionally they fed here in definite association with sea lions, *Zalophus californianus* (Lesson). Notes made on January 2, 1948 recounted such feeding behavior. Several cormorants kept associating with small to rather large groups of actively feeding sea lions, while avoiding a large group of merely migrating sea lions in the same area, then shifting to the larger group when it started to feed. The birds would fly over other sea lions to alight in the forward cluster of the most actively feeding of these very efficient fishing mammals. Whether the birds partook of wounded fish or fragments or merely used the feeding sea lions to locate the fish school was not clear. Probably the sea lions and cormorants were feeding on subsurface or mid-water fishes. On April 7, 1948, for at least 10 minutes, about 200 cormorants kept flying over a school of feeding sea lions just off the La Jolla kelp, to alight among the most actively feeding mammals.

That the Brandt's cormorants dive at times with sea lions, and that they commonly dive rather deep, are further indicated by records for this species made by one of us (C. L.) during his extensive scuba diving. During one descent they were seen diving with sea lions, two between 30 and 40 ft (9-12 m) and many between 40 and 50 ft (12-15 m), in the north branch of La Jolla Submarine Canyon, on December 31, 1955. Many were seen between 20 and 30 ft (6-9 m) on three dives off Scripps Pier, on December 6-8, 1955, and during one dive at the (submerged) "Rock Pile," south of the south island of the Los Coronados group, on February 28, 1950. Many were seen at depths between 10 and 20 ft (3-6 m) on nine dives off Scripps Institution, on one dive off Point Loma, and on one dive near the sewer outfall of

Tijuana, in Baja California a few miles below the international border, all during January and February, 1956.

Occasionally Brandt's cormorants succumb to feeding on fish affected by "red tide." Thus, large numbers of this bird came ashore sick or dead on September 14-19, 1955, from the feeding grounds between La Jolla and Del Mar, during and following a "red-tide" epidemic. About 30 per mile came on shore near Del Mar. On September 7 and 8 a mass mortality of queenfish, *Seriphus politus* Ayres, had been observed at La Jolla. Probably the cormorants had been feeding on poisoned individuals of this croaker, which is one of the dominant inshore, midwater fish of the region.

Brandt's cormorants seem to be very effective food gatherers. Often a large proportion of those utilizing the La Jolla rookery returned from their daily feeding within a few hours. They eat both large and small fish (Table 1). Many observations of the birds under water show them to be very rapid and flexible swimmers. Their high specific gravity and wettable feathers obviously require little or no expenditure of energy to remain submerged. Propulsion is by foot action only. No underwater use of wings has been observed in watching many individuals from the Scripps Pier and from ships. Observation for several months of a trained cormorant through a large window in an underwater act at Sea World in San Diego has verified the field studies. All of our observations confirm the stand taken by Gabrielson and Jewett (1940), and seem to negate the statement by Dawson (1923) that the wings as well as the feet are used in underwater swimming. That at least occasionally the feet are moved alternately is shown in an underwater photograph of one of the birds in Sea World, that was used for the cover figure of National Geographic Magazine for July, 1969.

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