CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

Volume 35 San Francisco, July, 1949 Number 3

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND GAME
San Francisco, California

California Fish and Game is [illegible] of wildlife. It is published quarterly by the California Department of Fish and Game. All material for publication should be sent to Dr. Carl M. Hubbs, Director of Fish and Game, Strawberry Canyon, University of California, Berkeley 4, California. Manuscripts should be typed, double spaced, [illegible] to the style of previous issues.

This publication is sent free of charge to interested persons, who may have their names placed on the mailing list by writing to the editor. Subscriptions are for one year and must be renewed annually. A postcard will be included with each October issue for renewal of subscriptions. Subscribers are requested to notify the Division of Fish and Game, University of California, Berkeley 4, California, of changes of address, giving old address as well as the new.

CALIFORNIA FISH AND GAME

"CONSERVATION OF WILDLIFE THROUGH EDUCATION"

VOLUME 35 ISSUED JULY 6, 1949 No. 3

TABLE OF CONTENTS

NOTES ON THE SPAWNING GROUNDS AND EARLY LIFE HISTORY OF THE PACIFIC MACKEREL[1]

By PHIL M. ROEDEL
Bureau of Marine Fisheries
California Division of Fish and Game

INTRODUCTION

For a number of years prior to 1942, the California Bureau of Marine Fisheries made a series of surveys along the California and Lower California coast in order to determine the extent of the spawning grounds of the Pacific mackerel, *Pneumatophorus diego* (Ayres). The work was purely exploratory. Nothing of a quantitative study of egg and larvae production was attempted, and the survey trips themselves were made erratically—usually in conjunction with other research projects—as vessels were available. In 1936, two papers were published (Fry 1936 a, b), the first describing the eggs and early larval stages and the second delineating the spawning grounds as they were then known. From 1936 through 1941, a considerable amount of additional data were obtained both as to spawning grounds and early life history. Because of the extensive egg and larval studies projected for Pacific coast fishes, it seems desirable to present this material, together with a summary of Fry's findings, as an aid to other workers.

SPAWNING GROUNDS

Surveys Prior to 1936

Fry (1936b) reported finding mackerel eggs in four areas: Southern California, Cape Colnett, southern Sebastian Viscaino Bay, and near Pequeña Bay. He found larvae but no eggs at Cape San Lucas and neither eggs nor larvae from Point Conception north to Monterey Bay. Eggs were found most abundantly in water less than 40 fathoms deep with surface temperatures between 62 degrees and 69 degrees F. None were collected beyond the 100 fathom line or in water colder than 57 degrees or warmer than 72 degrees. He notes that surface water temperatures north of Pt. Conception are usually below the 57 minimum.

Surveys Made 1936-1941

These surveys revealed that mackerel spawn along the entire coast from Southern California south to Cape San Lucas and into the Gulf of California at least as far as Espiritu Santo Island (Fig. 31). Though no eggs were collected in the gulf north of Espiritu Santo, larvae were found at several stations between the Island and Concepcion Bay (the northern limit of our explorations) and ripe adults were caught at Mangles Anchorage, about 115 miles above Espiritu Santo and 50 miles south of Concepcion Bay.

[1] Submitted for publication March, 1949.

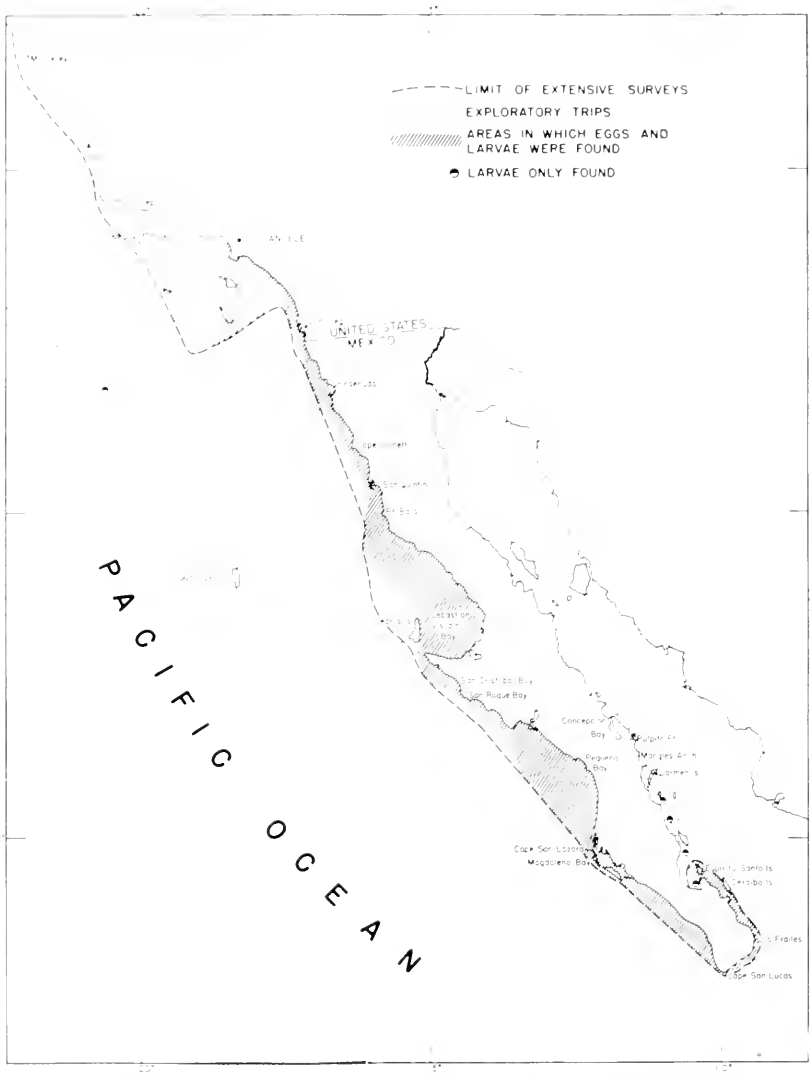

FIGURE 31. Known extent of the Pacific mackerel spawning grounds

Contrary to earlier findings, eggs and larvae were by no means uncommon in depths of up to several hundred fathoms, although they were usually found in water less than 100 fathoms deep. Eggs were never found and larvae found but once beyond the 1,000-fathom line. It is quite possible that they drifted to this position from shallower water. It must be noted that relatively few hauls were made outside the 100-fathom line except off Southern California. The data do indicate that spawning usually occurs fairly close to shore, though it does not appear to be as concentrated in shallow water as first appeared. Surface water temperatures at stations where eggs were found ranged from 59 degrees to 75 degrees F.

The most extensive surveys of Southern California waters were conducted from March through August, 1936. Other cruises were made in May, 1938, and in June and July, 1939. In addition, hauls were made along the mainland from Los Angeles harbor to San Diego on most of the Mexican trips discussed below. Eggs and larvae were found only in the months of May and June. (Fry reports the local spawning season as starting in late April and ending in August or perhaps September). The work in this region included two offshore cruises. The first, made in June 1939, extended some 180 miles beyond San Miguel Island, thence southeasterly to a point about 200 miles west of Ensenada, where three larvae were found in very deep water as noted above, and then to San Clemente Island. The second, made the following month, extended to Erben Bank (Lat. 32 53′N, Lon. 132 35′W), about 700 miles out of Los Angeles harbor. Neither eggs nor larvae were found. A single trip was made into Central California, this in August 1936. Inshore waters were explored as far north as Monterey Bay with negative results.

Nine cruises were conducted in Mexican waters from 1936 through 1941 as follows:

1. Late February-mid-March, 1936: To vicinity of Ceralbo Island, Gulf of California. Eggs and larvae found from Sebastian Viscaino Bay to Cape San Lucas, and larvae in the gulf north of Los Frailes.

2. Mid-June-mid-July, 1936: To vicinity of Ceralbo Island, Gulf of California. Eggs found in the southwest portion of Sebastian Viscaino Bay and off the center of Pequeña Bay at the 100-fathom line.

3. April, 1937: To the south shore of Sebastian Viscaino Bay. Eggs found between San Quintin and Baja Pt.

4. June, 1937: To Ensenada, offshore to Guadalupe Island, thence to the south shore of Sebastian Viscaino Bay, returning to Los Angeles harbor along the coast. Eggs and larvae found off Southern California and near Ensenada. This was the only cruise extending an appreciable distance offshore in Mexican waters.

5. Mid-March-mid-April, 1938: To Magdalena Bay. Eggs in Sebastian Viscaino Bay and north of Cape San Lazaro; larvae off San Cristobal Bay.

6. October, 1938: To Magdalena Bay. No eggs or larvae.

7. Late January-February, 1940: To Concepcion Bay, Gulf of California. Eggs and larvae found from north of Cape Colnett to Espiritu Santo Island; larvae to Pulpito Pt.; ripe adults at Mangles Anchorage. A station line was run offshore from Carmen Island to a point about 35 miles east of Ceralbo Island and thence to a point some 15 miles off Los Frailes. Results were negative, though both eggs and larvae had been found close to shore a few days earlier.

8. February, 1941: To Espiritu Santo Island, Gulf of California. Eggs and larvae found from near Ensenada to Espiritu Santo Island. Young fish, 36 to 54 mm. body length, were collected at Ceralbo and Espiritu Santo Islands, demonstrating that spawning begins, at least in the gulf, at an appreciably earlier date. Their age is not known, but it seems improbable that they were less than two or three months.

9. October, 1941: To Magdalena Bay. No eggs or larvae found.

The length of the spawning season in Lower California cannot be determined from these data. There is some indication that the season in the gulf is earlier than that along the Pacific Coast. It seems safe to say

that it begins no later than December in the gulf, and it apparently had ended there by June the year a trip was made in that month. North of Magdalena Bay spawning was continuing in June and July. While eggs were found in late January and February from the vicinity of Ensenada south, young fish, evidence of an appreciably earlier start to the season, were not captured.

DEVELOPMENT

Eggs and Larvae

Both the development of mackerel eggs and the early larval stages were described and figured by Fry (1936a). According to Fry, newly hatched larvae are about 3 mm. long. Melanophores are distributed irregularly on the oil globule, are found along the sides of the body, usually two on each myomere, and are scattered anteriorally. Yellow chromatophores form a yellow band around the tail, and occur at the posterior rim of the eyes and around the oil globule. At eight hours the melanophores begin to disappear and at 18 or 20 hours, black pigment may be almost lacking. By 30 hours, to quote Fry, "* * * a row of black spots has formed along the ventral side of the tail on each side of the fin fold and there is black pigment along the top of the body cavity. This pattern is retained until the larva is at least ten days old and probably longer. The yellow tail band dwindles in size; by $2\frac{1}{2}$ days it is a small patch, and by four days or less it has entirely disappeared."

Sizes up to 11 mm. (preserved measurements) are represented in subsequent collections and typical examples are shown in Figures 32 to 36. In the 4 mm. specimen pigmentation is much as described by Fry above. At 5 mm., pigmentation on the head and belly is more intense, but the melanophores on the posterio-ventral surface have disappeared. The 7 mm. specimen shows increased pigmentation anteriorally and a row of melanophores along the back. The pelvic fins can be seen. At 9 mm., pigmentation is somewhat less on the belly but is heavier elsewhere. The little fish at 11 mm. has still more melanophores on the head, and heavy rows of black spots along the back and along the bases of the anal and caudal fins.

FIGURE 32. Pacific mackerel, 4 mm. *Drawing by Gerhard Bakker, Jr.*

FIGURE 33. Pacific mackerel, 5 mm. *Drawing by Gerhard Bakker, Jr.*

FIGURE 34. Pacific mackerel, 7 mm. *Drawing by Gerhard Bakker, Jr.*

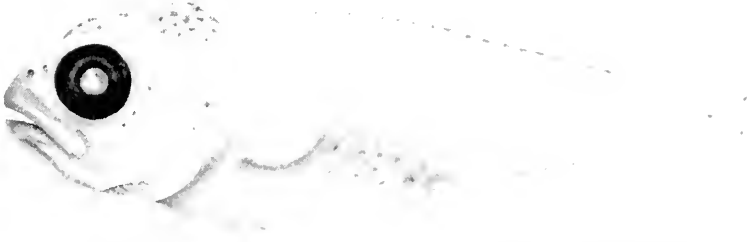

FIGURE 35. Pacific mackerel, 9 mm. *Drawing by Gerhard Bakker, Jr.*

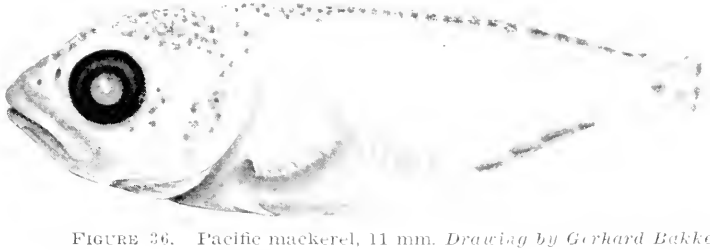

FIGURE 36. Pacific mackerel, 11 mm. *Drawing by Gerhard Bakker, Jr.*

Young Fish

Young fish over 11 mm. and less than 80 mm. are known only from a group of about 15 individuals ranging from 36 to 54 mm. body length. The 45 mm. specimen illustrated (Fig. 37) is typical of this group and is unmistakably a mackerel. When these fish were first caught, the beginning of the characteristic zebra stripes of the adult could be seen.

The markings consisted of a few rather heavy and but slightly wavy bars. No attempt was made to add them to the drawing which was made from preserved material. The specimens were taken in dip nets under a light while anchored in calm bays close to shore. Locality records include Isla Partida Harbor, Espiritu Santo Island and the southwest side of Ceralbo Island, both in the Gulf of California (Feb. 1941), and San Roque Bay, Lower California (Oct. 1941 and including the individual figured.

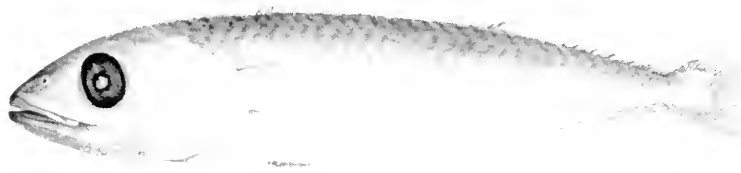

FIGURE 37. Pacific mackerel, 15 mm. *Drawing by Gerhard Bakker, Jr.*

Progression of Ossification in Larvae

In the course of a racial study of the mackerel, it was found that the initial position of several structures on the vertebral column varied in some degree with geographical locality. It then became desirable to know at what developmental stage the position of these structures became fixed. By following in general the KOH-alizarin method of Hollister (1934) we were able to obtain a highly satisfactory series of cleared and stained larvae up to 11 mm. in length. Examination of this material showed that the first haemal arch was closed on vertebra 11 in all individuals over 8.1 mm. while the first haemal spine appeared on vertebra 15 in those over 7.5 mm. These are the usual positions in over 90 percent of adult mackerel. The centra showed little evidence of ossification at this size.

Typical 5, 8, and 11 mm. specimens are shown in Figures 38 to 40. The drawings indicate clearly the progression of ossification. At 5 mm., the jaw bones, vomer, parasphenoid, basioccipital and all four opercular bones can be distinguished as can the ceratohyal and four of the branchiostegals. The hyomandibular appears as two widely separated pieces. The pectoral girdle and a few caudal rays are evident. The vertebral column shows no trace of ossification and the cranium but little.

FIGURE 38. Pacific mackerel, 5 mm., cleared and stained. *Drawing by Gerhard Bakker, Jr.*

At 8 mm., the quadrate, pterygoid, and metapterygoid are forming and all the branchiostegals are present. The urohyal is distinct, as are the branchial arches. The latter are not shown in the drawing for sake of clarity. From the dorsal aspect, a tiny supraoccipital crest can be seen. It lies below the level of the adjoining cranial bones in the lateral view. As stated above, the positions of the first haemal arch and spine are fixed at this size even though ossification of the vertebral column is

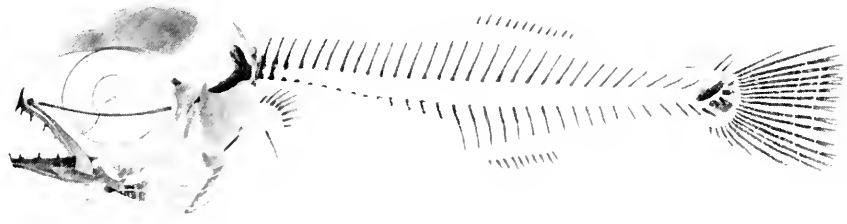

FIGURE 39. Pacific mackerel, 8 mm., cleared and stained.
Drawing by Gerhard Bakker, Jr.

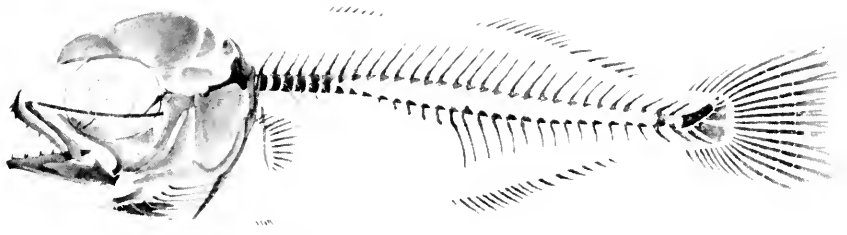

FIGURE 40. Pacific mackerel, 11 mm., cleared and stained.
Drawing by Gerhard Bakker, Jr.

confined to the first two and the last vertebrae. The first dorsal and pelvic fins remain undifferentiated, but the others are well marked.

The 11 mm. specimen shows considerable development over the 8 mm. stage. The two portions of the hyomandibular are joined and the palatines, mesoptergoid and basisphenoid are visible. Ossification of the vertebral column is progressing rapidly. The first six vertebrae are formed and ribs are taking shape. All fins are clearly defined and the five dorsal and anal finlets can be distinguished from the adjoining rays.

References

Fry, Donald H., Jr.

1936a. A description of the eggs and larvae of the Pacific mackerel. Calif. Fish and Game, vol. 22, p. 27-29.

1936b. A preliminary summary of the life history of the Pacific mackerel. *Ibid*, p. 30-39.

Hollister, Gloria

1934. Clearing and drying fish for bone study. Zoologica, vol. 12, no. 10, p. 89-101.

OBSERVATIONS AND NOTES ON SOME CALIFORNIA MARINE FISHES[1]

By JOHN E. FITCH
Bureau of Marine Fisheries
California Division of Fish and Game

The appearances of the several species of fish listed below are unusual enough to warrant a published record. These specimens have come to the attention of the California State Fisheries Laboratory since the last series reported by Fitch (1949).

Polydactylus approximans (Lay and Bennett) Pacific threadfin (Fig. 41)

A specimen approximately one foot in total length was taken by Mr. William O. Woodworth of Coarsegold, California, during the summer of 1941. He was fishing in the surf at Sunset Beach just south of Long Beach, California, and was using long-handed ghost shrimp (*Callianassa longimana* Stimpson) for bait. His catch was identified from excellent photographs which were sent to the laboratory in January, 1949. According to Mr. Woodworth the flesh of the threadfin proved to be quite tasty when it was eaten by his family.

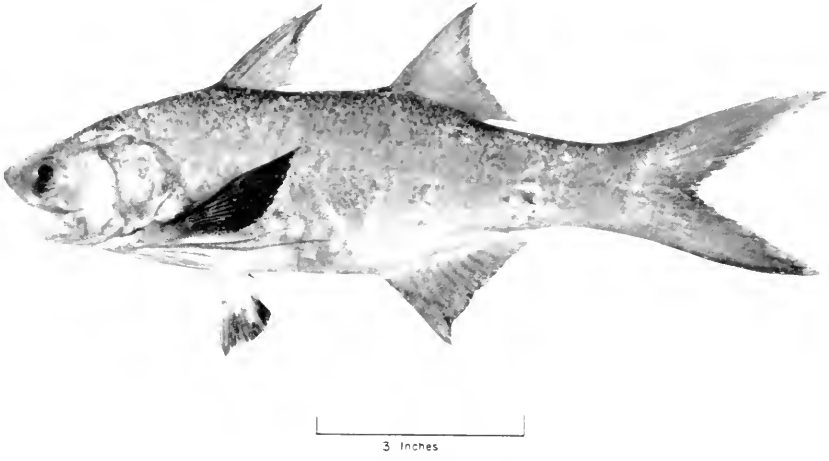

FIGURE 41. Pacific threadfin, *Polydactylus approximans*. Photo by Hawthorne Studios, Los Angeles

Barnhart (1936) gives the range of this species as the tropical east Pacific rarely to San Diego and Santa Catalina Island. Jordan and Starks (1907) state that this species is common about Mazatlan, and "has been once taken at Santa Catalina and once at San Diego." Follett (1948) in a review of this species gives the range from Callao, Peru to Santa Catalina Island, California. He also gives a detailed description of a

[1] Submitted for publication March, 1949.

specimen taken in Monterey Bay, California (a northerly extension of the recorded range) and lists seven other specimens taken in California waters and previously unrecorded.

Seven of the eight specimens he lists were taken during a 12-month period between August, 1940, and August, 1941. For the eighth he gives no date of capture. The specimen taken by Mr. Woodworth also falls into the 12-month period mentioned above and all except one were taken in the fairly limited area between San Clemente and San Pedro, California.

The number of specimens taken in California during this relatively short period opens to speculation the possibility that they were brought as far north as San Pedro during the summer of 1940 in the bait wells of a tuna clipper and dumped into our waters when the bait tanks were drained. For fish as small as these were, the above theory is entirely within reason; however in the absence of proof their occurrence this far north could be attributed as logically to natural migrations.

O. taylori (Girard) (Fig. 42) was also taken in considerable numbers in the same vicinity. The two species closely resemble each other and there is a certain amount of overlap in their ranges. *O. scrippsi* has four to six gill rakers in the lower limb of the outer gill arch while *O. taylori* has seven to nine. *O. scrippsi* is also deeper bodied and has a larger head.

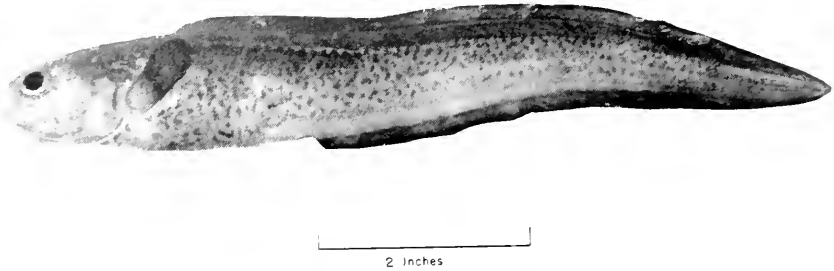

FIGURE 42. Spotted cusk-eel, *Otophidium taylori*. Photo by Al Johns for Vernon M. Haden, San Pedro

Spirinchus starksi (Fish) (Fig. 43) Night smelt

This species is a member of the true smelt family (Osmeridae) and in Northern California is of considerable commercial importance being marketed with several other kinds of small fish as whitebait. Its range according to Roedel (1948) extends from Monterey Bay, California,

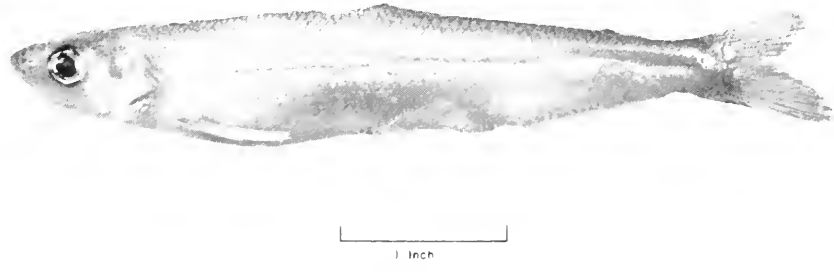

FIGURE 43. Night smelt, *Spirinchus starksi*. Photo by Al Johns for Vernon M. Haden, San Pedro

north into Washington. This fish is the northern counterpart of the grunion, *Leuresthes tenuis* (Ayres), which is found along the coast of Southern California. During its spawning season *Spirinchus starksi* runs into the extremely shallow water along the coast and though it does not actually beach itself as does the grunion it can be found in considerable numbers in the backwash of the waves. As with the grunion it also spawns at night.

During the operations of the oil exploration crews between Point Arguello and Morro Bay, California, in November and December, 1948, a number of these osmerids were killed and floated to the surface and were recovered by Wedgewood. Not only do these records extend the southerly range for this species some 100 miles beyond that given by Roedel, but also the fact that they were found in fair numbers and in water ranging in depth to 200 feet is of considerable importance. Previously they had been considered a shallow water form not usually occurring much beyond the breaker line in the surf.

Lepidogobius lepidus Girard Bay goby

An adult bay goby was picked up by Mr. Robert Wedgewood of the staff of the Bureau of Marine Fisheries some two miles off Pismo Beach, California in November, 1948. It was killed by a charge of explosives detonated at the surface of the water by a geophysical survey crew conducting a search for underwater oil deposits. Mr. Wedgewood recovered the specimen during a routine post-detonation inspection of the area when it was observed floating dead upon the surface along with a number of other species of fish killed in the same blast.

Lepidogobius is one of the very common shallow water gobies in the vicinity of San Francisco Bay and is found from there to Vancouver Island, British Columbia. South of San Francisco Bay it is a rare visitor and according to Barnhart (1936) has been recorded as far south as Lower California. It is of interest that the present specimen was killed in water between 100 and 200 feet deep and its collection adds to the localities where this species has been recorded south of San Francisco Bay.

Otophidium scrippsi Hubbs California cusk-eel

Three of these cusk-eels were also collected by Wedgewood off Point Arguello, California, during November, 1948, and several more were picked up in the same vicinity during December, 1948. All were killed by explosives and floated to the surface. Previously this species was known from Cedros Island, Lower California, to San Pedro. The present specimens extend the range to the north some 150 miles.

Lophotus sp. Crestfish

On August 20, 1948, a very rare crestfish or oarfish of the genus *Lophotus* was taken on hook and line near Santa Catalina Island (Fitch, 1949). This was but the second Pacific Coast record for this fish, the first specimen having been taken in 1919 near Long Beach, California. On January 29, 1949, just five months after this second crestfish was taken, another was landed, this by Mr. Norman Levin of Hollywood. Mr. Levin hooked his fish near Bel-Air while fishing some 85 yards offshore. He was using mussel (*Mytilus*) for bait and fishing on the bottom in what he estimated to be 80 feet of water. The specimen was almost exactly the same length as the one landed in August, 1948, and the external appearance identical. It weighed but four pounds for all its 39 inches of length

and according to Mr. Levin, put up "a little fight for about a minute." It has been preserved at Scripps Institution of Oceanography, La Jolla, California, where both it and the August, 1948, specimen will be studied and reported upon in considerable detail at some future date.

Neoclinus satiricus Girard Sarcastic fringehead

During January, 1949, Mr. Charles C. Isbell a commercial diver from Long Beach, California, brought into the laboratory the jaws of a fish he had taken off Santa Cruz Island. The extremely long maxillary and the bright yellow edge of an otherwise blackish maxillary membrane were the two characteristics which identified it as *Neoclinus satiricus*. Mr. Isbell stated that the specimen measured approximately 12 inches in total length, well over the nine-inch maximum given by Barnhart (1936).

The collection of the specimen was slightly unorthodox in that Mr. Isbell, working in 110 feet of water, had noticed a number of these fish living in holes along the bottom with their heads sticking up flush with the floor of the ocean. The jaws were partially open exposing numerous sharp teeth. Mr. Isbell struck one of the largest heads with a diving hammer, ran the stunned fish through with his belt knife and removed it from its burrow. From the size of the head he expected a specimen of considerable length and was extremely surprised to note the comparatively small body.

This species apparently lives in burrows in the bottom which may be one reason that specimens are not more often taken in drag nets and by other conventional methods of collecting. According to the diver's observations they are not too uncommon in a number of localities at moderate depths.

Rhinotriakis henlei Gill Brown smoothhound.

On November 3, 1941, a specimen of this shark was caught on hook and line at San Carlos Anchorage, Lower California (Lat. 29° 37′ N. Lon. 115° 28′ W.). The range of the species, limited to the coast of California in published records, is thus extended south some 200 miles below the Mexican boundary. The fish was caught during a cruise of the California Division of Fish and Game research vessel *N. B. Scofield* and was identified by R. S. Crocker and P. M. Roedel. An entry was made in the trip report but was overlooked in compiling previous articles on range extensions.

References

Barnhart, Percy S.
1936. Marine fishes of Southern California. Berkeley, Univ. of Calif. Press, 209 pp., 290 figs.

Fitch, John E.
1949. Some unusual occurrences of fish on the Pacific Coast. Calif. Fish and Game, vol. 35, pp. 41-49, 8 figs.

Follett, W. I.
1948. A northerly record of *Polydactylus approximans* (Lay and Bennett), a Polynemid fish of the Pacific Coast of tropical America. Copeia, 1948, no. 1, pp. 34-40, 1 pl.

Jordan, D. S., and Starks, E. C.
1907. Notes on fishes from the Island of Santa Catalina, Southern California. Proc. U. S. Nat. Mus. [for 1907], vol. 32, pp. 67-77, 8 figs.

Roedel, Phil M.
1948. Common marine fishes of California. Calif. Div. Fish and Game, Fish Bull. no. 68, 154 pp., 111 figs., 1 pl.

THE FOOD OF YOUNG LARGEMOUTH BLACK BASS (*MICROPTERUS SALMOIDES*) IN CLEAR LAKE, CALIFORNIA[1]

By Garth I. Murphy
Bureau of Fish Conservation
California Division of Fish and Game

INTRODUCTION

This study was undertaken to ascertain the mid-summer feeding habits of black bass of the year in Clear Lake, Lake County. A description of the feeding habits with increasing size of the fish was sought. In addition it was desired to learn the forage species most utilized by the bass, and whether or not cannibalism within the year class existed to an appreciable extent.

MATERIAL

The collections used in this study were seigned from Clear Lake during the period August 10-12, 1948, using a 40-foot by 6-foot, four to the inch mesh seine. All collecting was done along the five-mile stretch of shoreline between Lakeport and Rodman Slough, on the northwestern end of the lake. Two hundred and sixty-four whole specimens were preserved in formalin for later examination.

METHODS

Stomachs were removed from the preserved specimens, the contents sorted, and volumetric determinations of the various classes of food organisms made by water displacement in a graduated centrifuge tube.

All data from each specimen, including location of capture, length of fish, and the classes of food organisms in the stomach, were entered on "Speed Sort" cards. These have a series of holes in the margin. Data are entered on the cards by cutting out a wedge to the margin from the appropriate hole. A separate card is used for each specimen. Sorting is accomplished by inserting a needle in the appropriate hole and lifting the stack of cards vertically. All cards cut at that hole then drop out of the stack. This technique is used to sort the cards for any attribute of the specimens that has been entered. Considerable time is saved by using this system when dealing with multiple data on individual specimens, especially when multiple tabulations of the data are needed. The time required to enter the data on the cards is slight (about one minute per card when five entries are made) and the entries could be readily made by a clerk.

[1] Submitted for publication March, 1949.

GENERAL ECOLOGY OF THE STUDY AREA

The most prominent fish in the study area were largemouth black bass (*Micropterus salmoides*) bluegill (*Lepomis macrochirus*), sculpins (*Cottus sp.*), and greaser blackfish (*Orthodon microlepidotus*). Black bass of the year averaged 29 per seine haul; bluegill, intermediates (in this case, mainly fish of the 1947 hatch), and fry, averaged 77 per haul; blackfish averaged around eight per haul (exact counts were not made); and sculpins averaged about eight per haul (exact counts were not made). There were large numbers of bluegill too small to be taken in the seine. Sculpins could not be expected to appear in their true relative abundance since they live on the bottom and tend to escape capture by seine. Blackfish were actually more abundant in the lake than the figures indicate because the center of distribution of young of the year was farther offshore than the area in which the seine hauls were made, i.e., over 40 feet.

Insect foods, particularly larval midges and corixids (all instars), and zooplankton were abundant, judging from gross observations. In general, the food situation at the time was such that an abundance of the three types of food (fish, insects, and plankton) existed and presumably young bass were able to exercise choice in selecting their diet.

FOOD OF THE BASS

Table 1 gives the length frequencies of the specimens used. It does not reflect the size composition of the bass population because selection was exercised in order to obtain adequate representation from the various size classes. It does, however, represent the range of sizes of the bass of the year at the time the collections were made.

TABLE 1

Length Frequencies in Inches of Largemouth Bass Used in Food Study

Length class[1]	1.3	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.1
No. specimens	8	22	12	26	46	43	21	13	11	13
Length class[1]	3.3	3.5	3.7	3.9	4.1	4.3	4.5	4.7		
No. specimens	9	7	11	4	4	6	2	1		

[1] The figures given are the lower limits of the respective classes. Fork length was used.

Table 2 indicates the various types of food consumed by the bass, and gives an adequate picture of the relative importance of each food class in the diet.

TABLE 2

Food Classes Consumed by Largemouth Bass, Their Frequency of Occurrence and Total Volume

Class	*Frequency*	*Volume*
Fishes		
Blackfish	28	37.8cc
Bluegill	6	3.1cc
Sculpin	15	8.8cc
Carp (*Cyprinus carpio*)	1	1.0cc
Unidentified	24	7.2cc
Crustacea		
Water Fleas (Cladocera)	53	1.32cc
Scuds (Gammarids)	35	0.44cc
Insecta		
Water Boatmen (Corixidae)	142	6.04cc
Damsel Flies (Odonata)	32	1.38cc
May Fly (Ephemeridae)	8	0.08cc
Fly Larvae (Diptera)	38	0.40cc
Midge pupae (Chironomidae)	27	1.87cc
Unidentified	6	0.15cc
Miscellaneous Invertebrates	8	0.14cc
Empty	10	

Figure 44 indicates the relative importance of each major class of food to the various size groups of bass. The curves in Figure 1, although based on frequency of occurrence, indicate rather closely the actual importance of each class of food to the fish, in terms of volume of food. Plankton was an important food for fish below two inches in length, though decreasing in importance as the fish approached two inches in length. From 1.8 to 2.8 inches in length, insects were the most important dietary item, and from three inches upward fish were the only item taken in any significant amount. Generally, specimens larger than three inches in length that had taken foods other than fish had fish in their stomachs too, indicating that such items were incidental in their diet.

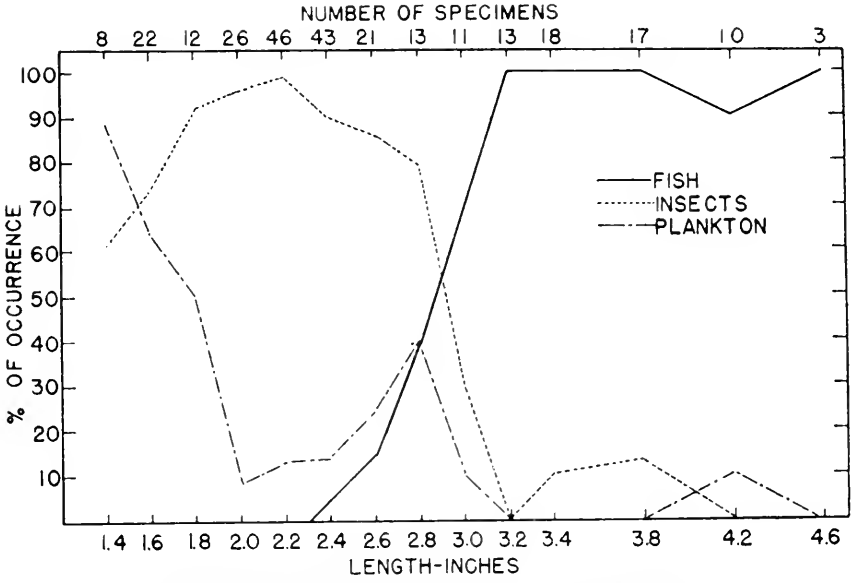

FIGURE 44. Composition of the stomach contents of young largemouth bass. The figures representing size are the lower limits of the classes

This transition in feeding habits is regarded as a natural change brought on by the choice of the individual fish. As pointed out earlier, all types of potential bass food were abundant in the area, making it possible for the bass to select the preferred food as opposed to limitations of supply dictating the selection.

Referring to Table 2, it is of interest to note the relative unimportance of bluegill in the diet. Judging by the composition of the seine haul catches, bluegill were the most important available forage fish. The hatch of the year ranging up to three-fourths inch in length was abundant while young blackfish were scarce. Young blackfish are probably more available than bluegill, since they inhabit the littoral zone, but are not closely associated with cover, while young bluegill tend to remain closely associated with plant cover. In addition, there may be a preference factor. Blackfish are a slender, fine scaled, smooth minnow, as opposed to the deepbodied, prickly bluegill. As an illustration of the consumability of young blackfish, a 2.4-inch partially digested blackfish was found in a 4.1-inch bass. The importance of blackfish as a forage fish as indicated

by the data herein presented is substantiated by spot checks on the stomach contents of young and adult bass in other sections of the lake, indicating that blackfish were the forage fish taken in greatest numbers during the last half of the summer season.

The frequency of sculpins in the bass diet (Table 2) was unexpected. These fish are not readily captured by seine since they adhere to the bottom, making seine haul estimates of their relative abundance unreliable. However, the data in Table 2 indicate that they play an important role in the littoral economy of Clear Lake.

No evidence of interyear class predation was obtained, though in some cases over seventy bass were captured in one seine haul, and the composition of the catch indicated that smaller bass were the most abundant food available to the larger bass. Probably the same factors, availability and desirability, that mitigated against the full utilization of young bluegill, operated in the case of smaller bass.

DISCUSSION

This study indicates that bluegill fry are not an important item of bass food in Clear Lake, though relatively abundant at the time the study was made. This is in opposition to experience in southern farm ponds, where bluegill constitute the chief bass forage. One factor relative to the usefulness of bluegill as forage fish in Clear Lake is the fact that they spawn about 1 to 1½ months later than the bass, due to their higher temperature requirement. Blackfish and other cyprinid forage fish spawn earlier than or about the same time as bass. In the absence of the fry of these fish, the young bass and sculpins must bear the brunt of the predation from older fish until the appearance of the bluegill hatch. Under such circumstances, one would expect a lower survival of bass to the fingerling stage. In 1947 the cyprinid spawning was a virtual failure, and bass of the year at fingerling size were only about one-eighth as abundant as during 1948.

Since blackfish are a lake spawning fish and since preliminary studies indicate that they are plankton feeders, they may be extremely valuable as forage fish in fluctuating reservoirs whose economy is almost solely dependent on plankton, just as the gizzard shad supplies forage in midwestern and southern reservoirs.

Cooper (1936) and Ohio Division of Conservation (1925) show a transition of feeding habits of young bass similar to that herein described, indicating the feeding pattern in Clear Lake is a normal one under environmental conditions favorable to the exercise of feeding choice by the bass. The work of Cooper (1936) was carried out under artificial rearing pond conditions and there are indications that the foods consumed by his specimens were to some extent forced on the fish by environmental limitations.

This study furnishes clues to the food picture that must be provided bass in nature and in rearing ponds if satisfactory production is to be obtained. The most important factor appears to be the provision of a supply of suitable-sized forage fish when the fingerlings reach 2.5 to 3 inches in length.

SUMMARY

1. The stomachs of 264 largemouth black bass of the year, collected from the northwest shore of Clear Lake during the period August 10-12, 1948, were examined.

2. The section of the lake from which the specimens were collected presented the bass with an abundance of the three main classes of food; namely, plankton, insects, and forage fish. It appears in all probability that selection of diet by the bass was a matter of choice and not environmental limitation.

3. Plankton and small insects were the chief foods of bass below 1.8 inches in length; insects the chief food of those between 1.8 and 2.8 inches; and fish almost the exclusive food of specimens over 2.8 inches in length.

4. Greaser blackfish were the most important forage fish taken, and corixids the most important insect food. Preliminary indications are that greaser blackfish may prove to be a desirable forage fish in fluctuating reservoirs.

5. No evidence of interyear class predation in bass of the year was detected.

Literature Cited

Cooper, G. P.

1937. Food habits, rate of growth and cannibalism of young largemouth bass *(Aplites salmoides)* in state-operated rearing ponds in Michigan during 1935. Trans. Am. Fish. Soc., vol. 66, 1936, pp. 242-266.

Ohio Division of Conservation

1925. The food of young large- and small-mouth black bass in Ohio. Ohio Division of Conservation, Bureau of Scientific Research, Bull. 10, 1925, 2 pp. mimeographed.

AGE AND LENGTH COMPOSITION OF THE SARDINE CATCH OFF THE PACIFIC COAST OF THE UNITED STATES AND CANADA IN 1948-49[1]

By Frances E. Felin[2]
United States Fish and Wildlife Service
Julius B. Phillips and Anita E. Daugherty
California Division of Fish and Game

This is a third report on age and length composition of the sardine *(Sardinops caerulea)* catch off the Pacific Coast of the United States and Canada and covers the 1948-49 season.

Methods of sampling the catch and determination of ages were continued in the same manner as formerly reported (Felin and Phillips, 1948).

In addition to the regular commercial fishing season of 1948-49 the California interseasonal fisheries at Monterey and San Pedro were sampled in 1948. For Monterey this interseason extended from February 16, 1948, to July 31, 1948, i.e., from the close of the regular 1947-48 season to the start of the 1948-49 season. San Pedro interseason fishing was carried on from March 2 to September 30, 1948. However, in Monterey no samples were taken during the "March" and "April" lunar months; and in San Pedro none were taken during "June" and "July."

For interseason fisheries age and length composition, estimated numbers of fish caught, mean lengths and standard error of the means of each year-class are presented in Tables 1 through 4.

For the regular season, Tables 5 through 7 give age and length composition in Oregon. No samples were obtained from the other Pacific Northwest ports in Washington and British Columbia where no sardine landings of any consequence were recorded. Tables 8 through 10 show similarly the same data for California ports together with the Pacific Northwest summary and a summary for the entire coast. Number of fish, mean length, and standard error of the mean of each year-class in the samples for 1948-49 by region of catch are given in Table 11. Calendar dates for lunar months in the 1948 interseason and 1948-49 season are given in Table 12. Table 13 gives age composition of the catch in terms of numbers of fish caught in the Pacific Northwest and in California. As in the 1947-48 season, no samples were taken of the very small landings at San Francisco.

Estimates of age from scales were made by the following biologists: Kenneth H. Mosher and Frances E. Felin of the U. S. Fish and Wildlife Service; J. B. Phillips and Anita E. Daugherty of the California Division

[1] Submitted for publication April, 1948.
[2] Published by permission of the Director, U. S. Fish and Wildlife Service.

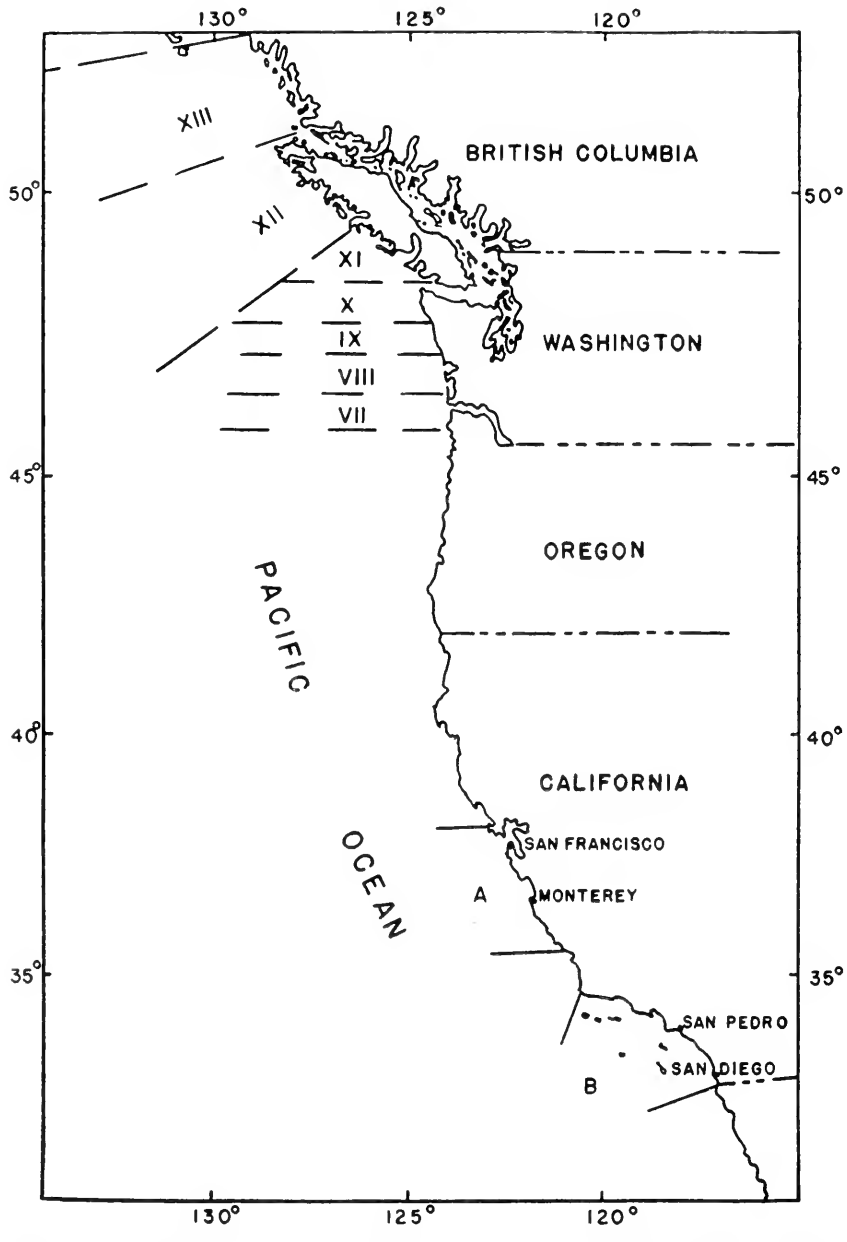

FIGURE 45. Sardine fishing areas. VII-XIII, areas in the Pacific Northwest fishery. (Areas V and VI off Oregon also were fished in 1948 and are of the same magnitude as areas VII and VIII.) A, San Francisco-Monterey fishing grounds. B. Southern California fishing grounds

of Fish and Game. The results of the determinations of age for the 1948-49 season are presented without interpretation.

We wish to thank the other agencies, the Fisheries Research Board of Canada, the Washington State Department of Fisheries, and the Fish Commission of Oregon for their continued cooperation in this program. The help of all those persons of the several agencies who have aided in the collection of scales, mounting of scale samples and in processing the data is gratefully acknowledged.

References

Felin, Frances E., and J. B. Phillips
1948. Age and length composition of the sardine catch off the Pacific Coast of the United States and Canada, 1941-42 through 1946-47. Calif. Div. Fish and Game, Fish. Bull. no. 69, 122 pp.

Mosher, Kenneth H., Frances E. Felin, and J. B. Phillips.
1949. Age and length composition of the sardine catch off the Pacific Coast of the United States and Canada in 1947-48. Calif. Fish and Game, vol. 35, pp. 15-40.

TABLE 1

Length Composition of All Year-Classes for Monterey 1948 Interseason

Length mm.	Year-classes															Total		
	1947			1946			1945						1939					
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
121		1	1														1	1
126																		
128		1	1														1	1
130																		
132																		
134																		
136																		
138	1		1													1		1
140																		
142	1		1													1		1
144	2	1	3													2	1	3
146	1		1													1		1
148	3	1	4													3	1	4
150	5	2	7													5	2	7
152	3	4	7													3	4	7
154	9	4	13													9	4	13
156	9	5	14													9	5	11
158	11	7	18		1	1										11	8	19
160	12	12	24		1	1										12	13	25
162	15	15	30													15	15	30
164	12	11	23	2		2										14	11	25
166	10	14	24	1		1										11	14	25
168	9	9	18		2	2										9	11	20
170	16	12	28	1	2	3										17	14	31
172	16	10	26		1	1		1	1							16	12	28
174	14	10	24	2		2										16	10	26
176	11	7	18	1	1	2										12	8	20
178	7	7	14	2	1	3										9	8	17
180	8	7	15	1	1	2										9	8	17
182	1	5	6	4		4		1	1							5	6	11
184	3		3	3		3										6		6
186	1	1	2	1	1	2										2	2	4
188				1	4	5										1	4	5
190		2	2	1	1	2										1	3	4
192				1		1										1		1
194																		
196					1	1											1	1
198				1	3	4										1	3	4
200																		
202				1		1	1		1							2		2
204																		
206																		
208																		
210				1		1										1		1
212																		
214								1	1								1	1
216																		
218							1	1	2							1	1	2
272														1	1		1	1
Totals	180	148	328	24	20	14	2	4	6					1	1	206	173	379

TABLE 2

Length Composition of All Year-Classes for San Pedro 1948 Interseason

Length mm.	Year-classes																		Total		
	1947			1946			1945			1944			1943			1942					
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
154					1	1														1	1
156																					
158																					
160				1		1													1		1
162	1		1	1		1													2		2
164				1		1													1		1
166				6	6	12													6	6	12
168	1		1	7	3	10													8	3	11
170				12	7	19													12	7	19
172	2		2	15	12	27													17	12	29
174				13	19	32	1	1	2										14	20	34
176				21	23	44	1		1										22	23	45
178				11	23	34													11	23	34
180				6	8	14													6	8	11
182	2		2	2	5	7	1	1	2										5	6	11
184		1	1	3	5	8													3	6	9
186				1	2	3													1	2	3
188	1		1	2	3	5													3	3	6
190	1		1	7	11	18													8	11	19
192		1	1	11	2	13		1	1										11	4	15
194				9	6	15	2		2										11	6	17
196				9	12	21		1	1	1		1							10	13	23
198				4	12	16	2	1	3		1	1							6	14	20
200				4	3	7	3	1	4										7	4	11
202				4	12	16	2	5	7		1	1							6	18	21
204				3	7	10	1	1	2	1		1							5	8	13
206				1	1	2		1	1										1	2	3
208				1	3	4	1	1	2										2	4	6
210							1	2	3		1	1		1	1				1	4	5
212					2	2	1	1	2	2	1	3							3	4	7
214							1		1										1		1
216								1	1	1	1	2		1	1				1	3	4
218							1		1					1	1				1	1	2
220													2		2				2		2
222																	1	1		1	1
224													1		1				1		1
226								1	1											1	1
228								1	1											1	1
238														1	1					1	1
Totals	8	2	10	155	188	343	18	20	38	5	5	10	3	4	7		1	1	189	220	410

[1] Includes one fish, length unknown.

TABLE 3

Age (Year-class) Composition of the Sardine Catch for Monterey and San Pedro 1948 Interseason

(Numbers of Fish Are Given in Thousands, i.e., 000 Omitted)

	Catch		Number of fish by year-class									
	Tons	Number	1917	1916	1945	1944	1943	1942	1941	1940	1939	1938
Monterey												
"February"	30	275		139	79	27	15	10	4		1	
"March"	139	1,287		619	369	125	71	49	18		4	2
"May"	1,259	19,811	15,059	3,566	1,189							
"June"	4,194	65,837	61,419	4,418								
"July"	4,394	61,104	55,464	4,699	471						470	
"August"	1,441	17,877	11,799	5,363	715							
Totals, Monterey	11,457	166,194	143,741	18,834	2,823	152	86	59	22		475	2
San Pedro												
"March"	517	7,423		7,292	131							
"April"	1,235	17,645		17,334	311							
"May"	187	2,621	210	2,306	105							
"June"	109	1,449	116	1,275	58							
"July"	97	760	25	557	152	26						
"August"	2,465	19,956	665	14,635	3,991	665						
"September"	5,512	45,963	1,416	31,468	7,425	2,827	2,473	351				
"October"	451	3,855	119	2,639	623	237	207	30				
Totals, San Pedro	10,573	99,672	2,551	77,506	12,796	3,755	2,680	381				
Grand totals	22,030	265,866	146,292	96,340	15,619	3,907	2,766	413	22		475	2

TABLE 4

Number of Fish, Mean Length and Standard Error of the Mean for Each Year-Class for Monterey and for San Pedro 1948 Interseason

Year-class	Monterey			San Pedro		
	No.	M.	S.E.	No.	M.	S.E.
1947						
Male	180	166	.71	8	177	3.52
Female	148	167	.82	2	188	4.00
Totals	328	166	.54	10	179	3.20
1946						
Male	24	182	2.30	155	181	.92
Female	20	181	2.83	188	184	.89
Totals	44	182	1.78	344[1]	182	.64
1945						
Male	2	210	8.00	18	199	2.86
Female	4	196	11.49	20	204	2.82
Totals	6	201	8.04	38	202	2.01
1944						
Male				5	208	7.16
Female				5	208	3.31
Totals				10	208	2.30
1943						
Male				3	221	1.33
Female				4	220	6.08
Totals				7	221	3.29
1942						
Male						
Female				1	222	----
Totals				1	222	----
1939						
Male						
Female	1	272	----			
Totals	1	272	----			

[1] Includes one fish, length unknown.

TABLE 5

Length Composition of the 1946, 1945, 1944 and 1943 Year-Classes by Areas in the Pacific Northwest in 1948

(Samples from Oregon Only)

Area	1946 Year-class, age 2			1945 Year-class, age 3			1944 Year-class, age 4												1943 Year-class, age 5											
	Unrecorded			Unrecorded			V			VI			VII			Total			V			VI			VII			Total		
Length mm.	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
202	--	1	1																											
234																														
236																						1	--	1				1	--	1
238																														
240																														
242																									1	--	1	1	--	1
244																														
246				1	--	1													1	--	1							1	--	1
248																			--	1	1	2	--	2	--	1	1	2	2	4
250													1	--	1	1	--	1				1	--	1				1	--	1
252													1	--	1	1	--	1	2	--	2	1	--	1	2	--	2	5	--	5
254																			--	2	2	2	--	2				2	2	4
256				--	1	1	--	2	2				--	1	1	--	3	3				1	--	1	1	2	3	2	2	4
258																			1	1	2	--	1	1	--	1	1	1	3	4
260											1	1	--	1	1	--	2	2	--	2	2	1	4	5	--	2	2	1	8	9
262											2	2				--	2	2	1	--	1	1	--	1				2	--	2
264										1	--	1				1	--	1				1	1	2	--	1	1	1	2	3
266													2	--	2	2	--	2				--	2	2				--	2	2
268													1	--	1	1	--	1				--	1	1				--	1	1
270																			1	1	2							1	1	2
Totals	--	1	1	1	1	2	--	2	2	1	3	4	5	2	7	6	7	13	6	7	13	11	9	20	4	7	11	21	23	44

TABLE 6

Length Composition of the 1942 and 1941 Year-Classes by Areas in the Pacific Northwest in 1948

(Samples from Oregon Only)

Area	1942 Year-class, age 6															1941 Year-class, age 7														
	V			VI			VII			Unrecorded			Total			V			VI			VII			Unrecorded			Total		
Length mm.	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
232																						1		1				1		1
234																														
236																														
238																														
240																														
242										1		1	1		1															
244				1		1							1		1	1		1				1		1				2		2
246										1		1	1		1															
248	1		1	2		2							3		3															
250				1	1	2				1		1	2	1	3															
252	1		1										1		1		1	1	1		1							1	1	2
254		1	1	2	1	6	1	1	2				3	3	6	1		1								1	1	1	1	2
256		1	1	1		1	2	1	3				3	2	5		2	2											2	2
258	1		1		1	1							1	1	2		1	1				1	2	3				1	3	4
260	1		1	1		1		1	1		1	1	2	2	4	1		1	1	1	2	2	1	4				3	2	5
262	1	1	2										1	1	2					2	2								2	2
264	1		1		1	1							1	1	2	1	1	2				1		1				2	1	3
266		1	1											1	1					1	1								1	1
268		1	1		1	1								2	2							1	1	2					1	1
270							1	1	2				1	1	2															
272	1		1		1	1							1	1	2							1	1	2					1	1
274								1	1					1	1							1	1	2					1	1
276																						1	1	2					1	1
278		1	1	1		1							1	1	2															
Totals	7	6	13	9	9	18	4	5	9	3	1	4	23	21	44	4	5	9	2	4	6	5	7	12		1	1	11	17	28

TABLE 7

Length Composition of the 1940, 1939 and 1938 Year-Classes by Areas in the Pacific Northwest in 1948

(Samples from Oregon Only)

Area	1940 Year-class, age 8															1939 Year-class, age 9														1938 Year-class, age 10		
	V			VI			VII			Unrecorded			Total			V			VI			VII			Unrecorded			Total			V		
Length mm.	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
248								1	1					1	1										1	--	1	1	--	1			
250							--	1	1					1	1																		
252							--	3	3				1	5	6		2	2	--	1	1							1	--	1			
254	1	--	1										1		1																--	--	--
256	1	1	2	--	1	1	--	3	3				1	5	6		2	2	--	1	1							--	3	3			
258				1	--	1	2	1	3				3	1	4				--	1	1							--	1	1			
260	--	2	2	2	3	5	1	--	1				3	5	8		1	1															
262	--	1	1	1	1	2							1	2	3					1	1								1	1			
264	--	2	2	1	--	1	1	--	1	--	1	1	2	2	4		1	1	--	--	--	1	--	1				2	--	2			
266				--	1	1	1	--	1				1	2	3	1	--	1				1	--	1				1	--	1			
268				1	2	3							1	2	3	1	--	1	--	1	1	--	1	1				1	2	3			
270	--	1	1	1	1	2							1	2	3																	
272				--	1	1							--	1	1																	
274	--	1	1										--	1	1																1	--	1
276	--	2	2										--	2	2	1	1	2										1	1	2			
278																1	--	1										1	--	1			
Totals	2	10	12	7	10	17	5	6	11	--	1	1	14	27	41	4	4	8	2	3	5	1	1	2	1	--	1	8	8	16	1	--	1

TABLE 8

Length Composition of the 1948, 1947 and 1946 Year-Classes in 1948-49

Length mm.	1948 Year-class, age 0			1947 Year-class, age 1									1946 Year-class, age 2														
	Grand Total[1]			Monterey			San Pedro			Grand Total[2]			Pacific Northwest[3]			Monterey			San Pedro			California			Grand Total		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
140				1	1	2				1	1	2															
142																											
144																											
146				1	3	4				1	3	4															
148					1	1					1	1															
150				4	4	8				4	4	8															
152				10	4	14				10	4	14															
154				8	4	12				8	4	12															
156				2		2				2		2															
158		1	1	6	7	13		2	2	6	9	15															
160				9	8	17		1	1	9	9	18															
162				8	15	23		2	2	8	17	25															
164				11	13	24				11	13	24															
166				12	11	23	1	1	2	13	12	25															
168				12	11	23	1	1	2	13	12	25															
170				14	10	24				14	10	24				1		1				1		1	1		1
172				16	10	26	1		1	17	10	27															
174				20	14	34		1	1	20	15	35															
176				12	8	20				12	8	20															
178				17	17	34				17	17	34															
180				23	9	32	1		1	24	9	33				1		1				1		1	1		1
182				15	10	25	1	1	2	16	11	27															
184				24	17	41	1	1	2	25	18	43				2	1	3	2	1	3	4	2	6	4	2	6
186				24	14	38	2	2	4	26	16	42				2	3	5	3	2	5	5	5	10	5	5	10
188				22	12	34	1	1	2	23	13	36				2	1	3	8	4	12	10	5	15	10	5	15

190				13	15	28	5	4	9	18	19	37				1	1	2	18	7	25	19	8	27	19	8	27
192				13	16	29	6	1	7	19	17	36				3	4	7	15	7	22	18	11	29	18	11	29
194				16	11	27	2	5	7	18	16	34				---	3	3	17	23	40	17	26	43	17	26	43
196				14	11	25	2	1	3	16	12	28				1	2	3	18	24	42	19	26	45	19	26	45
198				7	7	14	---	5	5	7	12	19				4	4	8	25	33	58	29	37	66	29	37	66
200				4	4	8	1	3	4	5	7	12				2	2	4	27	32	59	29	34	63	29	34	63
202				2	1	3	1	---	1	3	1	4	---	1	1	3	2	5	12	29	41	15	31	46	15	32	47
204				2	1	3	---	1	1	2	2	4				3	1	4	11	22	33	14	23	37	14	23	37
206				---	1	1				---	1	1				2	2	4	9	23	32	11	25	36	11	25	36
208																---	3	3	5	9	14	5	12	17	5	12	17
210																---	1	1	3	7	10	3	8	11	3	8	11
212																1	---	1	---	5	5	1	5	6	1	5	6
214																			1	2	3	1	2	3	1	2	3
216																			---	2	2	---	2	2	---	2	2
218																---	1	1	---	1	1	---	2	2	---	2	2
232																1	---	1			---	1	---	1	1	---	1
Totals	---	1	1	342	270	612	26	33	59	368	303	671	---	1	1	29	31	60	174	233	407	203	264	467	203	265	468

1 Year-class represented in California only at Monterey.
2 Year-class represented in California only.
3 Pacific Northwest represented by Oregon only.

TABLE 9

Length Composition of the 1945 and 1944 Year-Classes in 1948-49

Length mm.	1945 Year-class, age 3															1944 Year-class, age 4												
	Pacific Northwest[1]			Monterey			San Pedro			California			Grand Total			Pacific Northwest[1]			Monterey			San Pedro			California			Grand Total		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
186							1		1	1		1	1		1															
188																														
190																														
192																														
194								1	1		1	1		1	1															
196							2	1	3	2	1	3	2	1	3															
198							2		2	2		2	2		2															
200							6		6	6		6	6		6							2		2	2		2	2		2
202							3	2	5	3	2	5	3	2	5							3		3	3		3	3		3
204							1	6	7	1	6	7	1	6	7							1	2	3	1	2	3	1	2	3
206							3	5	8	3	5	8	3	5	8							2		2	2		2	2		2
208							3	2	5	3	3	6	3	3	6							1		1	1		1	1		1
210					1	1	8	11	19	8	12	20	8	12	20							2	1	3	2	1	3	2	1	3
212					1	1	3	8	11	3	9	12	3	9	12							1	4	5	1	4	5	1	4	5
214							1	8	9	1	8	9	1	8	9							1	2	3	1	2	3	1	2	3
216							2	4	6	2	4	6	2	4	6								2	2		2	2		2	2
218							4	6	10	4	6	10	4	6	10							1		1	1		1	1		1
220				2	2	4	1	2	3	3	4	7	3	4	7							1	1	2	1	1	2	1	1	2
222				1	1	2				1	1	2	1	1	2				1		1	2	2	4	3	2	5	3	2	5
224					2	2					2	2		2	2				1		1				1		1	1		1
226				2		2		2	2	2	2	4	2	2	4															
228					1	1					1	1		1	1				1		1	1		1	2		2	2		2
230				1	1	2		1	1	1	2	3	1	2	3															
232				1	2	3				1	2	3	1	2	3															
234					1	1					1	1		1	1				1		1				1		1	1		1
236				1		1				1		1	1		1															
238				1	1	2				1	1	2	1	1	2					2	2						2	2	2	2

240					1	1					1	1		1	1															
242																														
244																														
246	1		1										1		1															
248																1		1										1		1
250																1		1					1	1		1	1	1	1	2
252																														
254																	3	3											3	3
256		1	1											1	1															
258																	2	2											2	2
260																	2	2											2	2
262																1		1										1		1
264																2		2										2		2
266																1		1										1		1
Totals	1	1	2	9	15	21	10	59	99	49	74	123	50	75	125	6	7	13	1	2	6	18	15	33	22	17	39	28	21	52

[1] Pacific Northwest represented by Oregon only

TABLE 10

Length Composition of the 1943, 1942, 1941, 1940, 1939 and 1938 Year-Classes in 1948-49

Length mm.	1943 Year-class, age 5															1942 Year-class, age 6									1941 Year-class, age 7			1940 Year-class, age 8			1939 Year-class, age 9			1938 Year-class, age 10		
	Pacific Northwest[1]			Monterey			San Pedro			California			Grand Total			Pacific Northwest[1]			California[2]			Grand Total			Grand Total[3]			Grand Total[3]			Grand Total[3]			Grand Total[3]		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
214							2		2	2		2	2		2																				
216							1	1	2	1	1	2	1	1	2																				
218							1	1	2	1	1	2	1	1	2																				
220								1	1		1	1		1	1																				
222																																			
224								1	1		1	1		1	1																				
226																																			
228							1		1	1		1	1		1																				
230																																			
232																									1		1								
234	1		1										1		1																				
236																																			
238																																			
240	1		1										1		1																				
242																1		1				1		1											
244	1		1										1		1	1		1				1		1	2		2								
246	2	2	1										2	2	4	1		1	1		1	2		2											
248	1		1										1		1	3		3				3		3							1		1		
250	5		5										5		5	2	1	3				2	1	3					1	1					
252	2	2	4										2	2	4	1		1				1		1	1	1	2		1	1	1		1		
254	2	2	4										2	2	4	3	6	9				3	6	9	1	1	2	1		1					
256	1	3	4										1	3	4	3	2	5				3	2	5		2	2	1	5	6		3	3		
258	1	8	9	1		1				1		1	2	8	10	1	1	2				1	3	4	3	1	4		1	1					
260	2		2										2		2	2	2	4				2	2	4	1	1	2								
262	1	2	3										1	2	3	1	1	2				1	1	2	3	2	5	3	5	8					
264		2	2											2	2	1	1	2				1	1	2	2	1	3	1	2	3		1	1		
266		1	1											1	1		1	1					1	1	2	2	4	1	2	3	2		2		
268																	2	2					1	1	1	1	2	1	2	3	1	2	3		
270	1	1	2										1	1	2	1	1	2				1	1	2				1	2	3					
272																1	1	2				1	1	2	1	1	2								
274																	1	1					1	1		1	1				1		1		
276																										1	1		2	2	1	1	2			
278																1	1	2				1	1	2							1		1			
Totals	21	23	44	1		1	5	4	9	6	4	10	27	27	51	23	21	44	1		1	24	21	45	11	17	28	14	27	41	8	8	16	1		1

[1] Pacific Northwest represented by Oregon only.
[2] Year-class represented in California only at San Pedro.
[3] Year-class represented in Oregon only.

TABLE 11

Number of Fish, Mean Length, and Standard Error of the Mean for Each Year-Class in 1948-49 by Region of Catch

Year-class	Pacific Northwest[1]			California					
				Monterey[2]			San Pedro		
	No.	M.	S.E.	No.	M.	S.E.	No.	M.	S.E.
1948									
Male									
Female				1	158				
Totals				1	158				
1947									
Male				342	178	.70	26	188	1.72
Female				270	177	.82	33	186	2.48
Totals				612	178	.54	59	187	1.58
1946									
Male				29	196	2.14	174	197	.44
Female	1	202		31	198	1.48	233	200	.40
Totals	1	202		60	197	1.28	407	199	.30
1945									
Male	1	246		9	228	2.22	40	207	1.18
Female	1	256		15	225	2.53	59	211	.87
Totals	2	251	5.00	24	226	1.78	99	210	.73
1944									
Male	6	250	3.22	4	227	2.65	18	210	2.04
Female	7	257	1.47	2	238		15	216	2.78
Totals	13	258	1.67	6	231	2.85	33	213	1.73
1943									
Male	21	252	1.74	1	258		5	218	2.60
Female	23	258	1.19				4	220	1.73
Totals	44	255	1.10	1	258		9	219	1.56
1942									
Male	23	256	1.88				1	246	
Female	21	262	1.74						
Totals	44	258	1.34				1	246	
1941									
Male	11	254	3.03						
Female	17	262	1.70						
Totals	28	259	1.73						
1940									
Male	14	261	1.22						
Female	27	263	1.37						
Totals	41	262	.98						
1939									
Male	8	264	3.70						
Female	8	262	2.64						
Totals	16	264	2.24						
1938									
Male	1	274							
Female									
Totals	1	274							

[1] Samples from Oregon only.
[2] Monterey represented by local fish only. Fish trucked from Southern California not sampled at Monterey.

TABLE 12

Calendar Dates of Lunar Months for the 1948 Interseason and 1948-49 Season

"April"—March 26-April 23
"May"—April 24-May 23
"June"—May 24-June 21
"July"—June 22-July 21
"August"—July 22-August 19
"September"—August 20-September 17
"October"—September 18-October 16
"November"—October 17-November 15
"December"—November 16-December 14
"January"—December 15-January 13
"February"—January 14-February 12

TABLE 13

Age (Year-class) Composition of the Sardine Catch in the 1948-49 Season
(Numbers of Fish Are Given in Thousands, i.e., 000 Omitted)

	Catch		Number of fish by age (year-class)										
			0	1	2	3	4	5	6	7	8	9	10
	Tons	Number	1948	1947	1946	1945	1944	1943	1942	1941	1940	1939	1938
Pacific Northwest—Totals[1]	5,500	22,281			118	234	1,524	5,161	5,160	3,281	4,808	1,876	116
California—													
San Francisco													
Totals, San Francisco Local[2]	499	6,736	9	5,855	577	229	57	9					
Totals, San Francisco-So. Calif.	870	7,350		713	4,920	1,197	399	109	12				
Totals, San Francisco	1,369	14,086	9	6,568	5,497	1,426	456	118	12				
Monterey													
"August"—Local	3,213	38,546		33,408	4,498		320	320					
"September"													
Local	10,267	119,671		110,097	7,779	1,795							
Southern California	202	1,658		51	1,135	268	102	89	13				
Totals, "September"	10,469	121,329		110,148	8,914	2,063	102	89	13				
"October"													
Local	12,559	152,039		139,632	11,373	1,034							
Southern California	2,015	16,417		2,290	9,163	2,801	1,781	254	128				
Totals, "October"	14,574	168,456		141,922	20,536	3,835	1,781	254	128				
"November"													
Local	787	8,585		7,697	888								
Southern California	180	1,556		31	1,167	280	31	47					
Totals, "November"	967	10,141		7,728	2,055	280	31	47					
"December"													
Local	7,827	106,207	712	96,223	8,560	712							
Southern California	991	8,833		711	6,876	890	238	118					
Totals, "December"	8,818	115,040	712	96,934	15,436	1,602	238	118					

"January"													
Local	52	319		22	42	202	53						
Southern California	1,492	13,098		1,064	8,514	2,538	901	81					
Totals, "January"	1,544	13,417		1,086	8,556	2,740	954	81					
"February"—So. Calif.	841	7,730		1,546	4,417	1,435	221	111					
Totals, Monterey Local	34,705	425,367	712	387,079	33,140	3,743	373	320					
Totals, Monterey-So. Calif.	5,721	49,292		5,693	31,272	8,212	3,274	700	141				
Totals, Monterey combined	40,426	474,659	712	392,772	64,412	11,955	3,647	1,020	141				
San Pedro[3]													
"October"	30,450	248,646		34,686	138,770	42,419	26,978	3,854	1,939				
"November"	12,830	106,761		2,135	80,071	19,217	2,135	3,203					
"December"	44,376	394,071		31,723	306,783	39,683	10,601	5,281					
"January"	17,809	149,457		12,136	97,147	28,964	10,283	927					
"February"	9,444	86,984		17,397	49,702	16,153	2,488	1,244					
Totals, San Pedro	114,909	985,919		98,077	672,473	146,436	52,485	14,509	1,939				
San Diego[4]	2,940	25,187		2,443	16,862	4,101	1,368	373	40				
Totals, California	159,644	1,499,851	721	499,860	759,214	163,918	57,956	16,020	2,132				
Grand Totals, Pacific Coast	165,144	1,522,132	721	499,860	759,362	164,152	59,180	21,181	7,292	3,284	4,808	1,876	116

[1] Oregon only.
[2] Includes some fish trucked from Montery. All values for San Francisco, except tons landed, were prorated from Monterey totals.
[3] Includes some fish processed at Hueneme and about 890 tons trucked from San Diego to San Pedro.
[4] All values for San Diego, except tons landed, were prorated from San Pedro totals.

THE 1948-49 OUTBREAK OF FOWL CHOLERA IN BIRDS IN THE SAN FRANCISCO BAY AREA AND SURROUNDING COUNTIES[1]

By Merton N. Rosen[2] and Arthur L. Bischoff[2]

INTRODUCTION AND HISTORY

Fowl cholera is a disease commonly associated with chickens, turkeys, and other domestic poultry. The losses in ducklings on duck ranches in the State of Rhode Island are heavy, according to Hagan (1943). However, the disease has been thought to be decreasing in incidence in the United States, especially in the heavy poultry sections of the midwest.

The records of the Disease Laboratory of the California Division of Fish and Game recognized the occurrence of fowl cholera in wild ducks circa January, 1944. At that time Herman visited the Bethel Tract near Oakley and observed 1,000 dead coots. This outbreak occurred immediately following losses of domestic fowl in the area. There are indications that fowl cholera had occurred in wild ducks in the Mt. Eden area of South San Francisco Bay just prior to Herman's report of 1944. No records of the disease in wild birds during 1945 and 1946 were obtainable; however, farmers in the delta and south bay areas reported extensive waterfowl losses during those years. The fish and game records again refer to fowl cholera outbreaks in 1947 and 1948 from the Alviso area to the slough and island areas of the San Joaquin Delta.

CAUSATIVE ORGANISM

The organism responsible for fowl cholera is the small, oval, gram-negative bacterium, *Pasteurella multocida*. When it is seen in a blood smear strained by Wright's method, it is distinctly bipolar; Pasteur referred to it as the "figure of eight" bacillus. Some strains of the organism will grow with more or less difficulty on agar. The more virulent bacilli are the more fastidious in that they require agar enriched with blood or serum for growth. The strain isolated during the 1949 epizootic by the authors would grow best on a blood or serum enriched medium. There are three types of colonies: The fluoreseent is associated with epizooties of fowl cholera; the blue type occurs where the disease is enzootic or chronic; and a third intermediate type seems to be connected with outbreaks of severe cholera. The colonies isolated in the recent outbreak were of the last type.

The biochemieal reactions are in dispute, and some authors feel that sugar fermentation capabilities can be correlated with virulence of the

[1] Submitted for publication April, 1949.
[2] Federal Aid in Wildlife Restoration Act, California Project 35R. The authors wish to express their appreciation for the excellent cooperation freely given by Fish and Game Wardens Holladay, Bushey, and Cole and other personnel of the California Division of Fish and Game, to the personnel of the Leslie Salt Company and others who cooperated in this study.

strain, whereas other authors feel that the biochemical reactions are connected with host specificity. The virulence of the organism isolated from a canvas-back duck at Lake Merritt is known by the rapidity and unfailing effect with which death overtakes any experimental animal which ingests it. This strain does not ferment lactose, but does ferment glucose, arabinose, dulcitol, and xylose with production of acid but not gas. It produces indol after 48 hours incubation.

SYMPTOMS

In the explosive type of outbreak in poultry, all birds may be apparently healthy at night, but many may be found dead under the roosts on the following morning. No indicative symptoms precede death. This also was found to be the case in the beginning of the recent fowl cholera epizootic. No sick waterfowl could be seen for a period of one week to ten days after the onset of the disease. The birds were observed either in normal flight or loafing attitude, or else the carcasses were seen floating on the ponds or lying along the shoreline. After the first seven to ten days, a few, and later more and more waterfowl could be seen demonstating various symptoms. Indeed, the symptoms started by a few ducks appearing to be in a stupor, later becoming more diversified in such extremes as the inability to get off the water or an uncontrolled tumbling while in flight. Two ducks were observed gliding in for landings and folded their wings fully twenty feet above the water, crashing with great geysers of spray. Many of the wild birds slumped on the shore could be approached and picked up without showing any effort to escape. Others waddled away as best they could in their condition. Many birds were

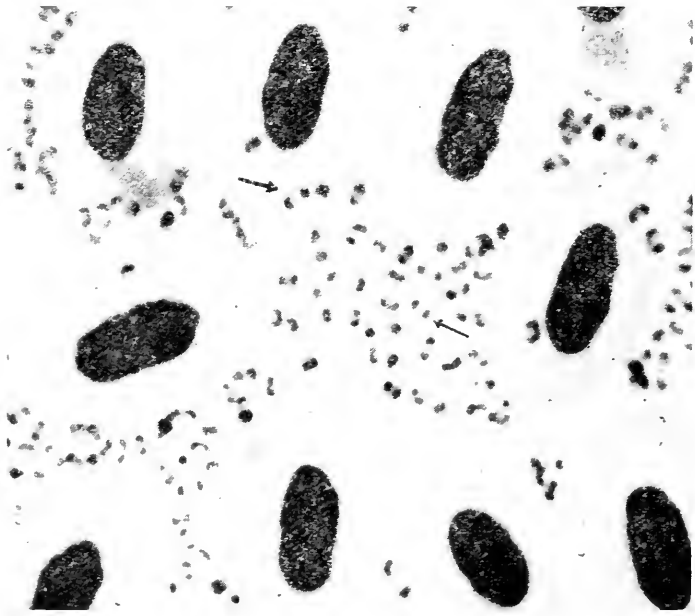

FIGURE 46. Typical picture of severe bacteremia in blood smear of duck after death from fowl cholorea. Arrows show characteristic "figure 8" organisms. X 3,000. *Photo by John Azevedo*

unable to hold up their heads, exhibiting the symptoms usually associated with botulism; if they were in shallow water, several would die of drowning before death from the disease could occur. Some sick coots and gulls did not attempt to get away but used the only defense remaining: snapping at the collectors. As the disease progressed diarrhea became more frequent in the waterfowl, producing watery greenish droppings. This condition is indicative of any disease affecting the intestinal tract.

PATHOLOGY

Minute hemorrhages occur on most of the mucous membranes. These petechial hemorrhages are most noticeable on the epicardium and myocardium. Focal necrosis occurs in the liver in the form of pinhead white or grey specks, this condition occurring with more frequency when the virulence of the organism has dropped in the last stages of an epizootic or the resistance of the host has been increased so that a longer course of disease is possible within the bird. Likewise, the tail end of the outbreak is indicated by the undulating flight of the ducks which is caused by an otitis media, with a pus formation in the middle ear frequently extending through the canals leading through the inner ear to the base of the brain. Septicemia is the result of blood vessel invasion by myriads of organisms: A true bacteremia is seen in the illustration (Fig. 46).

TRANSMISSION AND EPIDEMIOLOGY

Biester and Schwarte (1948) state that the infection is passed off by diseased birds through their excrement which contaminates soil, food and water. Gulls have been observed eating carcasses of other birds that have died of fowl cholera. Undoubtedly this scavenger practice contributes greatly to the rapid and widespread transmission of the disease. Although several authors maintain that feeding infectious material rarely produces the disease, 38 consecutive passages in coots were successful when employing intrapharyngeal instillation of a heart blood saline mixture. The coots would die within eight hours. However, the initial explosive outbreak of the disease remains unexplained by the above observations. It has been determined that the organism is harbored by apparently healthy animals in their respiratory tract. Merchant (1940) claims that droplet infection is of significance. Pritchet et al. (1930, 1932) isolated the infectious agent from the upper respiratory tract of supposedly normal birds and produced typical cholera in susceptible fowl. In Holland, Van der Hurk (1946) observed an epizootic of cholera that started with the arrival of wild ducks and caused a heavy mortality not only among their own numbers but to the domestic poultry of the country.

A mouse inoculated intraperitoneally with 0.5 cc. of water taken from a pond where many waterfowl had died, succumbed four hours after inoculation with prior symptoms of dyspnea and lacrimation. A blood smear revealed the typical bipolar organisms of fowl cholera. Confirmation was obtained by isolation of a pure culture of the organism. Fresh flights of ducks continued to pour into this particular pond. Gulls congregated along the shore devouring the carcasses of the mudhens and ducks. A cat was found dead with true secondary infection when the remains of a coot were found in his stomach.

Coots made up the greatest number of dead birds. Apparently the mudhen is more susceptible than any other waterfowl. In the outbreaks

observed by the authors, these birds made up from 70 to 100 percent of the mortality. Ducks of various species made up 10 to 20 percent of the total deaths, with gulls following closely with a mortality of 5 to 10 percent. Of the ducks the spoonbill was the most susceptible and the mallards were the least susceptible. Widgeon followed closely behind the spoonbill in high mortality rate, with the canvasback, teal, and sprig following in that sequence. A few shorebirds, phalarope, blue heron, tern, and sandpiper, also died of the disease. The so-called "susceptibility" is probably due to feeding habits rather than any innate decrease in resistance or relative immunity. The mortality rates are based on an equal distribution of numbers of the different species. It is felt that the gull is fairly resistant because they were the first sick birds observed after the start of the epizootic, and a few were observed to remain alive for a period of twenty-four hours while other birds were dying in less than ten hours. Many sick gulls were seen gliding in flight for two or three miles and landing in distant ponds. The gull movement may well be one of the principal modes of transmitting the disease to new areas. The authors have observed the diseased gulls in areas prior to death of any waterfowl.

On the seventh of December, 1948, the laboratory was notified that ducks were dying in the vicinity of Alviso. Experimental mice were inoculated with heart blood of the dead ducks. Within four hours pure culture material of *Pasteurella multocida* was obtained from the blood stream. Domestic ducks were inoculated with the infectious material and the virulence of the organism was established with the death of the ducks in from six to eight hours. The site of the outbreak was immediately adjacent to the San Jose garbage dumps where hundreds of gulls congregated to eat the offal. With the realization that this epornitic had the potential to devastate large numbers of ducks through its high virulence and by ease of transmission through the large number of gulls that were in the area which would be succumbing to the disease, a reconnaissance was made of the duck ponds to the north of Alviso. No evidence of northward spread of fowl cholera could be found in the Irvington and Newark areas at the time.

At the start of the second week of the epizootic, it was found that fowl cholera was killing ducks, coots, and gulls beyond Irvington—approximately six miles north of the initial point at Alviso. More and more ponds were being flooded around Alviso and to the north as far as Alvarado (15 miles airline from the focal point), to attract ducks as the forthcoming hunting season grew nearer. This not only provided impetus for new flights to land but served to scatter those birds exposed to the disease. Within ten days of the initial outbreak, coots by the hundreds were being picked up near the Leslie salt ponds at Newark. One small pond of six acre-feet yielded a collection of six hundred dead ducks just a few days after the disease broke out on it. The ponds involved in the initial outbreak continued to cause the death of thirty to forty ducks per day. Several thousand ducks were succumbing to fowl cholera as the second half of the duck season began. The northward spread continued with reports of dead ducks extending up the west side of the bay from Sunnyvale to Millbrae. Storms and hunting pressure seem to have lessened the mortality about Alviso temporarily. Ducks scattered before the concentrated assault of the sportsmen. Some of the waterfowl apparently sought refuge in the sanctuary of Lake Merritt in Oakland.

The disease started in this city lake with fifteen to twenty ducks per day being picked up. A decline in mortality to seven per day two weeks after the onset of the epizootic, and then in three weeks a sudden increase to 30 ducks a day mortality occurred. The losses continued until the beginning of April.

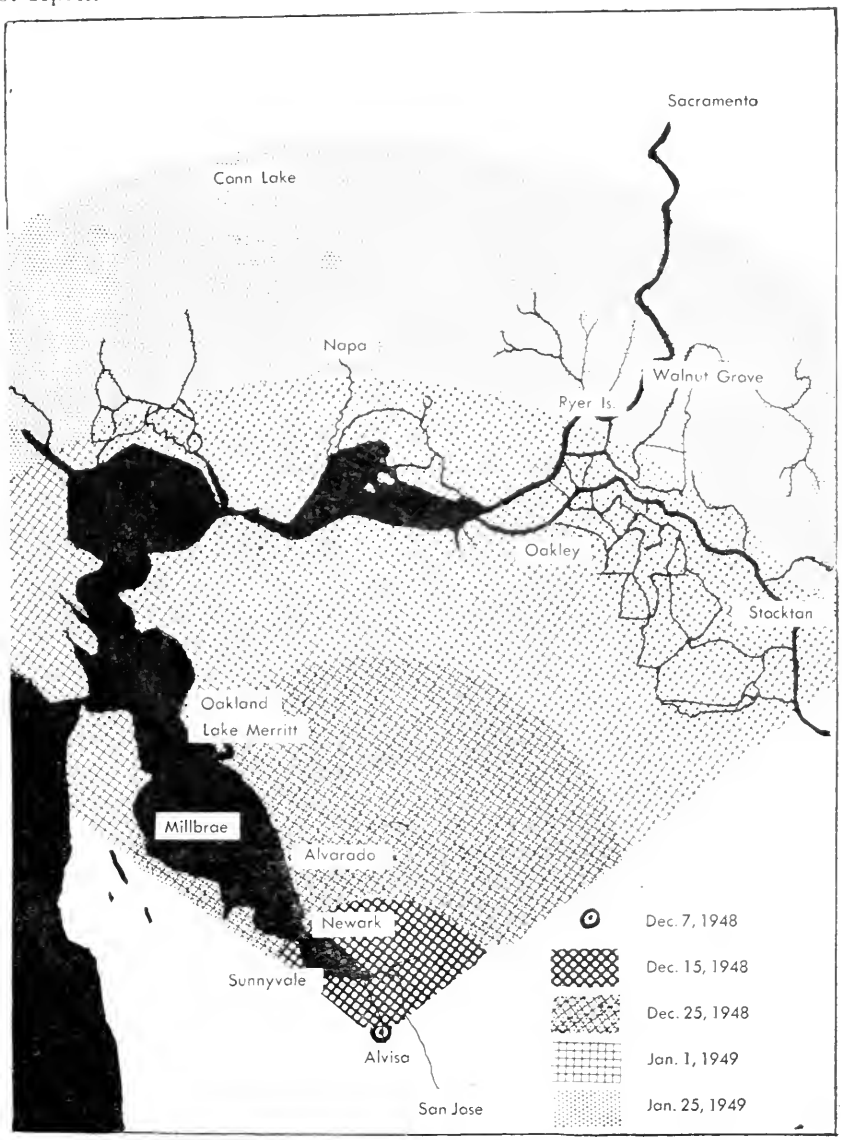

FIGURE 47. The northward spread of fowl cholera in wild birds during the 1948-49 outbreak

The death wave continued to fan out as illustrated in the accompanying map. Near Prospect and Ryer Islands on the Rio Farms of the delta 15 ducks were picked up in one hour along a drainage ditch. Mortality in this area dropped following the close of the season, and by the

end of January an all-day search resulted in finding 50 coots, some of which were very much decomposed. On the north and west the disease continued by breaking out at Conn Lake in Napa County on about January 25th. This outbreak involved at least one thousand five hundred waterfowl, 90 percent of which were coots. The disease waned about the middle of February.

An outbreak of cholera was investigated in the area south of Walnut Grove and west of Lodi in which the losses were primarily swans with very few coots and apparently no ducks. Approximately one hundred carcasses were observed. How the disease was transmitted to these birds is a matter of conjecture. The theory that apparently healthy birds may carry the organism and succumb to it when the resistance of the host is lowered may account for this outbreak.

The northward migration of the waterfowl leaving the diseased areas terminated reports of losses from fowl cholera. Observers of the Division of Fish and Game stationed in the Sacramento Valley noted the arrival of the northward migrating birds, and, warned of the possibility of fowl cholera being transmitted along the flyway, kept a careful watch for the disease.*

CONTROL AND PREVENTION

In domestic poultry, when confronted with a severe outbreak resulting in heavy losses, the recommended procedure is depopulation except where the disease is so well established as to present a problem of recurrence. The premises should not be repopulated until the natural purification of sun and air has had enough time to take effect. Draining of water is a recommended procedure. All carcasses should be carefully collected and burned. Disinfectant is applied to the walls, roosts, nests, feed and water containers as liquor cresolis, formalin, or lye.

Some of the above procedures have an analogy in fowl cholera as it occurs in the wild as modified by practicability and economic considerations.

The immediate suggestion to cooperating individuals such as caretakers of private or commercial duck clubs, farmers, and sportsmen is to pick up all carcasses and effectively dispose of them by burning. The gross contamination of the environment and the continually increasing concentration of organisms is thereby combatted to some extent.

As the initial confirmed diagnosis of fowl cholera was made at the four ponds near Alviso, and based on the reproduction of the disease in mice through the inoculation of the pond water, a recommendation was made that those particular ponds serving as the infectious focal point be drained on an experimental basis. It was thought that this procedure would effectively dispose of the contaminated water and prevent fresh flights of ducks from entering the diseased area. The owner of one of the ponds complied with the request and drained all water from his ponds. An owner of a duck pond 200 feet distant from these drained, agreed to act as the control base and retain his ponds in their flooded state since his pump did not have the capacity to refill his pond in time for the

* Since this manuscript was prepared the authors learned of mortality among ducks at the Sacramento Waterfowl Refuge of the U. S. Fish and Wildlife Service near Willows, California. The outbreak apparently reached its peak about March 21st. An estimated 2,000 birds were on the pond where the losses occurred. Between 100 and 150 ducks succumbed. A diagnosis of fowl cholera was made on a sample of these birds by the pathology laboratory of the California Bureau of Animal Industry.

opening of the second half of the duck season. He continued to pick up from thirty to forty dead ducks each day.

A concentration of 1:5000 solution of copper sulfate was mixed with infectious blood in a test tube. Experimental animals were inoculated with the mixture after intervals of 15 minutes, 30 minutes, and one hour. Those birds injected with the 15- and 30-minute mixtures succumbed within a few hours after treatment whereas those inoculated with the hour mixture survived. The experiment was carried into the field with the procurement of 4,600 pounds of copper sulfate. Two tons were dissolved in drums with the aid of hydrochloric acid and mixed with water that was refilling the ponds that had been drained. Six hundred pounds were used to treat the water in an infected pond near Sunnyvale. Three days after treatment, water samples were collected and concentrated in an ultracentrifuge at 17,000 revolutions per minute. The concentrates were inoculated into mice without effect. Inasmuch as this treated water had been fresh and no further deaths had occurred between the time of treatment and the procurement of samples for concentration, a conclusion as to the efficacy of this experiment cannot be drawn. A survey of the south bay disease areas disclosed a small residue of infection in the coots and gulls, but the severity of the initial infection had disappeared. Storms and hunting pressure and with the attendant movement of duck populations, possible decline of virulence in the organism had brought about a temporary lowering of the mortality rate.

On being apprised of the appearance of fowl cholera in Lake Merritt, the cooperation of the City of Oakland was solicited, in order that the lake might be flushed out by opening the flood gates leading into the estuary and bay. Salt water was allowed to flow into the lake by letting the flood gates remain open during high tide. The disease continued with a slight decrease in mortality. This procedure was initiated with the hope that a noticeable effect of salt water on the organism would result, based on the observation that while fresh water ponds near Alviso had heavy losses of waterfowl upon them, the salt water ponds and marshes had no observable losses.

SUMMARY AND CONCLUSIONS

An epizootic of fowl cholera started during the first week of December, 1948, on fresh water ponds at the south end of San Francisco Bay near Alviso. This outbreak was thought to be a continuation of similar ones which had occurred during the winter of each of the preceding four years.

The causative organism was a virulent strain of *Pasteurella multocida* that would grow best on a blood or serum enriched medium. It proved to be of the intermediate or Group III type in that it did not ferment lactose, but fermented glucose, arabinose, dulcitol, and xylose with the production of acid but no gas. Characteristically, indol was produced.

At the beginning of the outbreak no symptoms were observed in the waterfowl: they were either dead or alive. Symptoms of the disease became apparent during the second week of the epizootic with sick birds huddled on the shoreline unable to fly, several drowning in shallow water through the inability to hold up their heads, or tumbling or undulating in flight. Greenish diarrhea became prominent among the birds slumped

along the shoreline. Autopsied ducks showed minute hemorrhage of the heart with some reddening of the intestinal tract. In the last stages of the outbreak some swans had the pin-point, grey necrotic foci in the liver. Microscopically, the multitudes of bacteria in the blood stream could be easily demonstrated.

The scavenger habits of gulls eating the carcasses of waterfowl that had died of the disease seemed to contribute greatly to the rapid and widespread transmission of the disease. Proof of the infectivity of the water was obtained by the death of a mouse that had been inoculated intraperitoneally with 0.5 cc. of water taken from a pond where many waterfowl had died.

The spread of the epizootic was traced from the focal point at Alviso gradually north through Lake Merritt and on up through the delta. Approximately forty thousand waterfowl perished from the disease before the northward migration coincided with the end of reports of waterfowl losses.

Acting on the procedures followed by the poultry industry, carcasses were picked up by cooperating individuals and agencies and burned. Depopulation and cleansing of premises were attempted by drainage of a few ponds to prevent fresh flights of ducks from entering those ponds and by disposing of the contaminated water. Experimentally, 4,600 pounds of copper sulfate were used to treat three ponds. The results of this procedure are questionable due to factors which came into play immediately after application. As the disease started in Lake Merritt, the flood gates were opened with the hope that contaminated water would flow out and any disinfectant action that salt water might have could take effect with the introduction of bay water during high tide. No noticeable effect resulted from this action.

All of the experimental control measures were performed under pressure of the epizootic. Circumstantial evidence indicates possible value to the measures applied during the outbreak. Investigations and research are continuing on fowl cholera with the application of field experiments in an effort to determine where the responsibility for initiation of an outbreak lies, on control, and on other factors as they relate to the disease.

References

Biester, H. E. and Schwarte, L. H.
1948. Diseases of poultry. Iowa State Col. Press, Ames, Iowa. 1154 pp.

Hagan, W. A.
1943. The infectious diseases of domestic animals. Comstock Publ. Co., Ithaca, N. Y. 665 pp.

Hurk, C. F. G. W. van der
1946. Aanteekeningen by de epizootie van vogel cholera over Nederland in het najaar van 1945. Tijdschr. Diergeneesk, vol. 71, pp. 361-365.

Hutyra, F. and J. Marek and R. Manninger
1949. Diseases of domestic animals. Alexander Eger Inc., Chicago, Ill., 3 vols.

Merchant, I. A.
1940. Veterinary bacteriology. Iowa State Coll. press, Ames, Iowa, 628 pp.

Pritchett, I. W., F. R. Beaudette and T. P. Hughes
1930. Epidemiology of fowl cholera, IV. Field observations of the "spontaneous" disease. Jour. Exper. Med., vol. 51, p. 249.

Pritchett, I. W. and T. P. Hughes
1932. The epidemiology of fowl cholera. VI. The spread of epidemic and endemic strains of *Pasteurella avicida* in laboratory populations of normal fowl. Jour. Exper. Med., vol. 55, p. 71.

DISEASE INVESTIGATIONS ON MAMMALS AND BIRDS BY THE CALIFORNIA DIVISION OF FISH AND GAME[1]

By Carlton M. Herman[2] and Merton N. Rosen[3]
Bureau of Game Conservation
California Division of Fish and Game

During the past 40 years the California Division of Fish and Game has been as active in the study of wildlife diseases as any similar agency in other states. Until recent years the work was intermittent and was discontinued at times for lack of funds or lack of adequately trained personnel. The present program has been in progress since July, 1942.

The earliest disease investigations by the California Division of Fish and Game were undertaken during the period 1911-1913 when Frank C. Clarke was assigned to study deer losses in the north coastal counties of California and duck disease in the San Joaquin Valley.

Following these preliminary studies the program was renewed in 1928 under the jurisdiction of the Bureau of Research. Dr. K. F. Meyer, Director of the Hooper Foundation of the University of California Medical School was appointed consulting pathologist. Dr. Earl C. O'Roke was hired as parasitologist, Dr. Henry Van Roekel as pathologist and Robert J. Irvine as chemist. In 1929 Paul H. Shaw became toxicologist. In this same year Van Roekel and O'Roke resigned to accept positions in the east. In 1930 Dr. M. Hobmaier was appointed pathologist and Gordon H. True, Jr., was indirectly assigned to a temporary position on the staff since part of his assigned duties were to study the relation of deer to growing crops and part to investigate diseases of and their relation to domestic livestock. In 1932 True was assigned to the Bureau of Game Farms in charge of field production of game. Further personnel were not employed by the division for investigations of parasites until the senior author was appointed in July, 1942.

In July, 1933, the financial situation of the division made necessary many extensive cuts in personnel and the entire disease program was discontinued. The toxicologist was maintained on the division staff but his duties were primarily concerned with pollution investigations.

During this period, 1928-1932, the staff made contributions to our knowledge of diseases in captive birds at state game farms, described a malaria parasite of quail, and clarified our knowledge of duck disease in California. The work on duck disease was undoubtedly the most outstanding of this period. After much investigation on the possibilities of alkali poisoning, the studies led to the diagnosis of type C botulism, confirming the findings of the U. S. Biological Survey.

[1] Submitted for publication April, 1949.
[2] Parasitologist, in charge.
[3] Federal Aid in Wildlife Restoration Act, California Project 35R.

4—7140

In 1938 the junior author, who had been working on the pollution detail, was assigned to study botulism. This work was discontinued two years later when Rosen was granted leave of absence for military duty. In July, 1942, the senior author was appointed in charge of the disease investigations of the Bureau of Game Conservation.

During the period 1928-1932, laboratory facilities were made available at the Hooper Foundation. In 1938 Rosen had available facilities at the Hooper Foundation but prior to his leave of absence laboratory facilities were housed in a one-room structure on the pier at the Ferry Building in San Francisco. The program in 1942 was renewed with these inadequate facilities. In April, 1945, the U. S. Navy took over the location of the laboratory and temporary quarters were obtained in the Life Sciences Building on the campus of the University of California in Berkeley. In August, 1945, the activities were moved to our present quarters in a remodeled CCC Building on the campus in Strawberry Canyon. These facilities are shared with the food habits study project 25R which is a part of the federal aid program of the division.

Both staff and equipment of the disease investigations project have been increased gradually until at present we have a good working unit. Rosen returned in February, 1946, and is now senior bacteriologist. Recently work has been divided and part of the program is carried as Federal Aid in Wildlife Restoration Project California 35R, "A Study of Diseases of Wildlife Species in California." The staff for this phase of work includes Merton N. Rosen, senior bacteriologist; Arthur I. Bischoff, laboratory technician; John Azevedo, laboratory assistant; and Burke Zane, laboratory helper. The last employee is on a half-time basis. The remainder of the staff includes, Carlton M. Herman, parasitologist, in charge; Alvin Hightower, hunter and trapper; Barry Tarshis and Kenji Sayama, laboratory assistants on a half-time basis; and Mildred I. Goodman, intermediate stenographer-clerk.

TYPES OF INVESTIGATIONS

Several types of investigations are undertaken by the staff of the laboratory. All of these have specific purposes for which they are designed. Incidence studies are fundamental in determining the importance of particular parasites or diseases. Methods of employing management practices in controlling disease is another phase of the work. The laboratory may be employed as a service for cooperation with management of particular species or range in using certain testing methods. Control of disease under captive conditions such as the state game farms may be employed, e.g. blood testing of breeding stock. Investigations can lead to employment of field experiments and recommendations as a result of those experiments. Primary examples are presented in the work that has been and is being done.

One of the first projects undertaken in 1942 was a study of the parasites of quail. One phase of our investigations on coccidia has been completed and published, indicating that these intestinal protozoa are of widespread occurrence in the wild birds. It was also determined that these parasites take a toll of quail and chukar partridge at some of the game farms. Studies are still in progress in an effort to determine the factors involved governing the occurrence of this disease in the wild.

In the study of blood protozoan parasites we have obtained a vast amount of material. Blood smears have been procured from several thousand individual quail, mostly trapped birds primarily collected as part of other studies on this species. These data have been supplemented by studies on captive quail at the various state game farms and experiments at the laboratory. The earlier work of O'Roke indicated that the louse fly *Lynchia hirsuta* is a possible vector and subsequently we have implicated the large louse fly *Stilbometopa impressa* as a carrier of the *Haemoproteus*-malaria parasite. Very little of our data on this project have reached publication pending clarification of several new forms found and further statistical analysis of the information on hand. Various phases of this study are still in progress and the program has been expanded in some directions in an effort to clarify data obtained in the earlier stages of our surveys and experiments.

No work has been done on botulism in the past few years because of its diminished occurrence in most of California. The chief area where losses have occurred in past years, Tulare Lake, has presented no problem since the main body of water has been dried up.

Studies on fowl cholera have become our main concern in our investigations of waterfowl disease. Potentially losses may become severe enough to decimate seriously our present waterfowl population. Our chief efforts are an attempt to determine the source of this infection and the mechanisms by which it is carried from one area to another or from one year to the next and from this data to develop such control measures as may be feasible.

Extensive work has been completed on studies of various diseases and parasites of deer. The main problems confronting us now are to determine methods of combatting stomach worm infections and various other diseases that occur in these animals. During the recent dry years so-called foot rot—infections involving the organism *Spherophorus necrophorus*—has been the most evident disease and has taken a heavy toll in several areas. Now, with the advent of a wet winter, stomach worms and other parasites have become predominant and are causing losses, particularly in younger deer.

An extensive project is in progress to determine the blood picture of deer, including blood chemistry, in the expectation of finding reliable factors that can be used as an indicator of the animal's condition. It is anticipated that the results of this study will give us a base that can be used as an index of the state of nutrition of the deer as it relates to range management, and incidentally classify the anemias that may occur in these animals.

Perhaps the greatest progress has been made in our efforts at the state-owned game farms. Pullorum disease (a bacterial disease of the intestinal tract of gallinaceous birds known as bacillary white diarrhea) is the number one problem of the domestic poultry of the State, and the California Department of Agriculture and poultry industry are making extensive efforts to keep this disease under control. Evidence of the infection in game farm pheasants led us to undertake a control program. Our results indicate that this disease has been eradicated from all our game farm units and constant check is being made to keep birds free of this infection.

In recent years avian type tuberculosis probably was among the greatest causes of deaths occurring in adult pheasants and chukars at one of the game farm units. Management procedures employed to combat this disease have apparently practically eliminated the infection and cases of tuberculosis are now rare.

Experiments on the control of gapeworm infections in the game farm birds are being attempted at the present time but have not progressed sufficiently as yet to justify an analysis of the applied measures. Studies are also in progress on so-called quail disease, ulcerative enteritis, which takes a heavy toll of the game farm quail.

Various other projects have been undertaken or are in progress but these either have not progressed sufficiently or are of a minor nature and do not warrant detailed mention in this review.

SURVEYS AND DIAGNOSIS

One of the chief projects of the laboratory staff is the collection of survey data to determine what parasites and diseases occur in our wildlife, the incidence, prevalence and distribution of these infections in the wild and their relative importance. It also is necessary to act as a service unit in the diagnosis of losses which may occur from disease. These two phases of our work are coordinated so that specimens obtained for diagnosis serve as the chief source of the material for survey data. This is frequently supplemented by special studies, such as examination of hunter-killed specimens and examination of specially trapped animals. The findings under this procedure serve as the governing basis by which the special research problems requiring investigation are determined. The main success of this program depends on the cooperation of field personnel, particularly the patrol force who are constantly in the field and in the best position to observe the problems as they arise. Members of the field staff of the Bureau of Game Conservation also play a role in this phase of our work and the men working on management programs and predatory animal control have proved very helpful, particularly where further specific data are needed to clarify a diagnosis or to obtain sufficient survey material to present valid statistical information.

The procedure for handling such material varies considerably according to circumstance. It is sometimes necessary to travel into the field to collect sick specimens. At such times having an experienced hunter and trapper assigned to our staff is of tremendous aid. The cooperation of members of the patrol force is extremely helpful at these times.

Frequently freshly dead specimens come into the possession of wardens and require examination at the laboratory. These may be brought into the laboratory or members of the laboratory staff may go into the field to procure them.

In cases where specimens are to be shipped to the laboratory the method of handling may be very important. The specimens may be packed in borax powder, frozen in dry ice, preserved in formalin or some other technique may be employed. The efficacy of any preserving method depends on the use to which the laboratory must put the material in order to make a diagnosis. No hard and fast rules of procedure can be recommended for field personnel to follow in every case. It seems best at present to advise the field personnel to contact the laboratory without

delay when specimens come to hand so that they may be informed of the best method of handling. In cases where special material is to be collected for a specific purpose previous discussion with a member of the laboratory staff is usually sufficient to determine methods of handling.

As far as possible with existing staff and facilities diagnosis is determined at the Berkeley laboratory of the bureau. On occasion, where necessary, other agencies cooperate either by making a specific diagnosis or by confirming our own findings. Frequently other agencies and institutions in various parts of the State have cooperated by making their facilities available to us when working in their area. With our mobile laboratory this procedure is no longer as necessary as in the past.

The special mobile laboratory of the division is a valuable adjunct to the Berkeley laboratory. This vehicle was designed to fill the need for rapid diagnosis of wildlife disease in the field. The emphasis was placed on mobility and maneuverability so that the site of a disease outbreak

FIGURE 48. The mobile laboratory. *Photo by Kramer Adams.*

could be reached quickly even in areas that might be considered somewhat inaccessible. It also was considered important that it contain all of the necessary facilities for complete diagnosis in the fields of bacteriology and parasitology so that it would be a completely self-sustained laboratory. Since this is a new type of equipment for the study of wildlife disease a description of the unit is given.

The mobile laboratory is based on a one-ton panel truck. (Fig. 48). The vehicle has four speeds forward including a compound low gear. The generator has been replaced by an alternator that produces 80 amperes

for charging three storage batteries. One of the storage batteries is used in the normal manner, while the other two in series provide 12 volts. The current produced runs an inverter which supplies a 110-volt alternating current, providing power for three fluorescent lamps, an air conditioning fan, a centrifuge and for other uses that may occur.

A five-gallon butane tank is mounted on a plywood partition behind the driver's seat. This supplies fuel for the bunsen burner and gas may also be used as a source of heat when outside temperatures make it necessary and to prevent the breakage of bottles containing reagent solutions that might freeze.

Mounted from the ceiling directly behind the driver's seat is a 30-gallon water tank filled from the outside. This water supplies the sink and the air conditioning unit. A refrigeration box is directly behind the driver's seat with a metal lined box and insulated with glass wool. Ordinary ice or CO_2 dry ice may be used as the refrigerant.

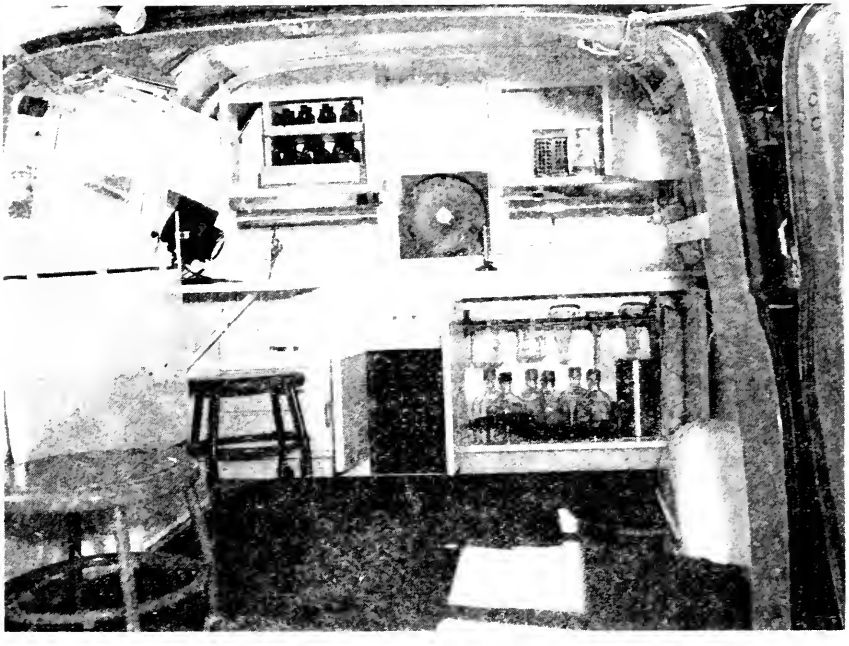

FIGURE 49. View of interior of the mobile laboratory. *Photo by Kramer Adams.*

The inside of the truck provides the working space for laboratory procedures (Fig. 49). Cabinets and drawers are installed on the partition. Reagent bottles and glassware are fitted into rubber lined slots mounted in a shelf that slides out for convenience. A compartment was constructed that holds the microscope in its case for double protection. Two folding tables and the sinkboard provide workspace. Eighteen-inch library-type steel stools with rollers give adequate working space, and allow two workers to move about the quarters that otherwise would be cramped. Windows were cut through the panel side above the folding tables to

provide adequate light, and the interior is painted white to insure maximum use of natural light. Two swinging brackets mounted above the rear doors provide for suspension of deer or other large mammals for ease of performing a necropsy. An aluminum table with an adjustable leg is hinged to the floor at the rear entrance so that the internal organs can be examined outside, or where birds or small mammals can be autopsied.

This vehicle has proven invaluable in the rapid diagnosis of disease at locations away from the headquarters laboratory. In addition to its usefulness in providing a means of quickly determining the cause of a disease and thereby allowing all preventive and control measures to be initiated with greater dispatch, this mobile laboratory has been used in extending research on particular diseases to the field environment where they occur.

The main concern of the laboratory is the study of parasites and diseases of game species of mammals and birds. Since many of the infections also involve other species of animals, it is often necessary to investigate the infections of non game species in order to obtain the complete picture of epidemiological relationships. An effort is made to confine our research for the most part to specific problems that will yield data necessary to anticipate or ultimately instigate control measures. However, it is usually necessary to have at hand much academic information which is basic to any further study. As much as possible academic problems that lend themselves to such procedure are farmed out to qualified graduate students or other individuals whose personal interests tie in with material we have on hand or can obtain easily. Further, when studies are completed on material which would be of teaching value, such specimens are presented as gifts to various colleges to be used for classroom or research study.

On many occasions various members of the faculty of the University of California, other institutions, and personnel of the Departments of Agriculture and Public Health have cooperated or collaborated with us on some of our problems which have interests in common. Several joint research and survey projects have also been undertaken.

The study of diseases of wild life is still very much in its infancy. Often much more time is required to obtain a diagnosis or the answers to many of the problems than the results might seem to warrant. Efforts to obtain a diagnosis of losses occurring in the field frequently seriously interrupt the research projects necessary to obtain the basic data which are imperative before any progress toward control can be anticipated. As our knowledge advances it will become even more necessary that the assistance of collaborating individuals and institutions be procured if the information on the basic academic phases of our problems is to be available and keep pace with our efforts to solve the ultimate purpose of our existence—the control of wild-life diseases.

Bibliography

Chattin, J. E., C. M. Herman and H. Kirby
1944. A parasite from antelope in California. Trans. Amer. Microsc. Soc., vol. 63, pp. 27-29.

Clarke, F. C.
1913. Preliminary report upon the disease occurring among the ducks of the southern San Joaquin Valley during the fall 1913. Condor, vol. 15, pp. 214-226.
1913. Investigations on the large game situation in California with special reference to deer. Calif. Game Bull. No. 1, pp. 6-20.

Dixon, J. S.
1934. A study of the life history and food habits of mule deer in California. Calif. Fish and Game, vol. 20, pp. 182-282, 316-354. Section on diseases, pp. 274-282.

Dixon, J. S., and C. M. Herman
1945. Studies on the condition of California mule deer at Sequoia National Park. Calif. Fish and Game, vol. 31, pp. 3-11.

Dougherty, E. C., and C. M. Herman
1947. New species of the genus Parafilaroides Dougherty, 1946 (Nematoda: Metastrongylidae), from sealions, with a list of the lungworms of the Pinnipedia. Proc. of Helminth. Soc. Wash., vol. 14, pp. 77-87.

Hensley, A. L., and B. C. Fox
1948. Experiments on the management of Colorado River Beaver. Calif. Fish and Game, vol. 34, pp. 115-131. This paper has a section entitled "disease study" on p. 129.

Herman, C. M.
1943. Giardia in the blood of a kangaroo rat. Jour. Parasit., vol. 29, p. 423.
1943. An outbreak of mycotic pneumonia in mallards. Calif. Fish and Game, vol. 29, p. 204.
1944. Eye worm *(Thelazia californiensis)* infection in deer in California. Calif. Fish and Game, vol. 30, pp. 58-60.
1944. Notes of the pupal development of *Stilbometopa impressa* (Diptera: Hippoboscidae). Jour. Parasit., vol. 30, pp. 112-118.
1944. The blood protozoa of North American Birds. Bird-Banding, vol. 15, pp. 89-112.
1945. Hippoboscid flies as parasites of game animals in California. Calif. Fish and Game, vol. 31, pp. 16-25.
1945. Gapeworm in California quail and chukar partridge. Calif. Fish and Game, vol. 31, pp. 68-72.
1945. *Cephenemyia jellisoni* Townsend (Diptera Cuterebridae) reared from nasal bot of blacktailed deer. Pan-Pac. Ent., vol. 21, p. 120.
1945. Deer management problems as related to diseases and parasites of domestic range livestock. Trans. 10th N. A. Wildlife Conf., pp. 242-246.
1945. Some worm parasites of deer in California. Calif. Fish and Game, vol. 31, pp. 201-208.
1946. The nose bot fly of deer. Calif. Fish and Game, vol. 32, pp. 17-18.
1947. Further observations on deer foot worm infection. Calif. Fish and Game, vol. 33, p. 54.
1949. A new host for the eye worm *Thelazia Californiensis*, Calif. Fish and Game, vol. 35, pp. 139.
1949. Coccidiosis in native California valley quail and problems of control. Trans. Conf. on Coccidiosis, New York Academy of Sciences, March, 1949. In press.

Herman, C. M. and A. I. Bischoff
1946. The footworm parasite of deer. Calif. Fish and Game, vol. 32, pp. 182-190.

Herman, C. M. and G. L. Bolander
1943. A parasite in the muscles of ducks in California. Calif. Fish and Game, vol. 29, pp. 148-149.
1943. Fungus disease in glaucous-winged gull. Condor, vol. 45, pp. 160-161.

Herman, C. M. and J. E. Chattin
1943. Epidemiological studies on coccidiosis of California Quail. I. Occurrence of Eimeria in wild quail. Calif. Fish and Game, vol. 29, pp. 168-179.

Herman, C. M. and J. E. Chattin and R. W. Saarni
1943. Food habits and intensity of coccidian infection in native valley quail in California. Jour. Parasit., vol. 29, pp. 206-208.

Herman, C. M. and Pedro Galindo
1944. Notes on a water ouzel. Condor, vol. 46, p. 297.
Herman, C. M. and B. Glading
1942. The protozoan blood parasite *Haemoproteus lophortyx* O'Roke in quail at the San Joaquin Experimental Range, California. Calif. Fish and Game, vol. 28, pp. 150-153.
Herman, C. M. and H. A. Jankiewicz
1943. Parasites of cottontail rabbits on the San Joaquin Experimental Range, California. Jour. Wildlife Mgt., vol. 7, pp. 395-400.
Herman, C. M. and M. N. Rosen.
1947. Another outbreak of Fungus Disease in Gulls. Condor, vol. 49, p. 212.
Hobmaier, M.
1930. Duck disease caused by the poison of the bacillus botulinus. Calif. Fish and Game, vol. 16, pp. 285-286.
1930. Duck disease caused by the toxin of Clostridium botulinus. C. Proc. Soc. Exper. Biol. Med., vol. 28, pp. 339-340.
1932. Conditions and control of botulism (duck disease) in waterfowl. Calif. Fish and Game, vol. 18, pp. 5-21.
Interstate Deer Herd Committee.
1947. Second progress report on the cooperative study of the interstate deer herd and its range. Calif. Fish and Game, vol. 33, pp. 287-314. This paper has a section entitled "parasites" on pp. 310-312.
McLean, D. D.
1930. The quail of California. Div. of Fish and Game, State of California Game Bull. No. 2. A section entitled "diseases and parasites of the valley quail" prepared by E. C. O'Roke appears on pp. 35-37.
1946. Duck disease at Tulare Lake. Calif. Fish and Game, vol. 32, pp. 71-80.
Mays, A. S.
1941. Observations on duck disease at Tulare Lake Basin, 1940. Calif. Fish and Game, vol. 27, pp. 154-164.
Meyer, K. F.
1928. Facts you should know about animal diseases—an elementary talk. Calif. Fish and Game, vol. 14, pp. 107-114.
Moffitt, J.
1934. Mule deer study program. Calif. Fish and Game, vol. 20, pp. 52-66.
O'Roke, E. C.
1928. The relation of parasitism to wild life conservation. Calif. Fish and Game, vol. 14, pp. 128-129.
1928. Parasites and parasitic disease in the California valley quail. Calif. Fish and Game, vol. 14, pp. 193-198.
1928. Intestinal parasites of wild ducks and geese. Calif. Fish and Game, vol. 14, pp. 286-296.
Rosen, M. N.
1948. Hermaphroditism in Chinese ring-necked pheasant. Calif. Fish and Game, vol. 34, pp. 135-136.
Rosen, M. N. and A. I. Bischoff.
1949. Field trials of sulfamethazine and sulfaquinoxaline in the therapeusis of quail ulcerative enteritis. Cornell Vet., In press.
Shaw, P. A.
1930. Recent progress in duck disease studies. Jour. A.V.M.A., vol. 77, pp. 561-568.
1933. Toxicity and deposition of thallium in certain game birds, J. Pharm. & Exp. Ther., vol. 48, pp. 478-487.
1933. Colorimetric determination of thallium. Ind. Eng. Chem., vol. 5, pp. 93-99.
Van Roekel, H.
1929. Wild duck disease. Calif. Fish and Game, vol. 15, pp. 11-12.
1929. Diseases observed in game bird raising. Calif. Fish and Game, vol. 15, pp. 301-308.
1929. Parasitism in deer. Calif. Fish and Game, vol. 15, pp. 309-314.

NOTES

LARGE DOVER SOLE TAKEN OFF EUREKA

On September 21, 1948, the otter trawler *St. Patrick*, captained by Earl McCarty of Eureka, obtained a catch of very large Dover sole, *Microstomus pacificus*. Several fish ranged from 7.5 to 10.3 pounds in total weight. Total lengths of these large fish varied from 646 mm. to 710 mm., a range of 25.43 to 27.95 inches. All were taken in the same drag, at a depth of 100 fathoms, northwest of Humboldt Bay bar. The maximum length previously given for this species was 24 inches. The largest specimen obtained was a female with ovaries large, distended and granular. The ova were approaching the translucent condition that occurs prior to spawning. Ovum diameters ranged from 1.0 mm. to 1.2 mm. Measurements on this fish were: 710 mm., or 27.95 inches, measured from the tip of the snout to the longest caudal ray; standard length 615 mm., 24.2 inches; depth of the body 342 mm., or 13.47 inches; round weight 10.30 pounds. Scales taken from this individual indicated an age between 18 and 20 years.—*Frederick B. Hagerman, Bureau of Marine Fisheries, California Division of Fish and Game, April, 1949.*

REVIEWS

Trout Fisheries in New Zealand, Their Development and Management

By Derisley F. Hobbs, New Zealand Marine Department, Wellington, New Zealand, Fisheries Bulletin Number 9, 1948, 175 pp., 31 plates, 25 tables, appendix 5.

This book will be welcomed by all who are working on trout fishery management problems.

Mr. Hobbs has covered his subject well. He has set down in a clear manner a review of the development of trout fishing in New Zealand from the time of introduction of the first trout into the country, about 1865, until the present time. He describes the part played by trout hatcheries, which were established at the time of the first shipment of eggs into the country. The primary function of hatcheries then was to receive trout from other countries in the only stages they could be safely transported at the time, namely eyed eggs. Later the hatcheries were used in an attempt to maintain the fishery at a high level. The author questions their value as an important adjunct to natural reproduction. In his discussion relating to the efficiency of natural reproduction versus hatchery production he calls attention to the "unconcious propaganda of numbers." "The number of eggs handled in hatcheries sound impressive and look impressive on paper until they are viewed in relation to the number of fish which produce them or the number of eggs not handled in hatcheries." Some of the author's general conclusions about hatcheries in New Zealand are: "the losses resulting from interference with natural spawning runs and the artificial propagation of eggs obtained have usually been greater than would have occurred had fish been left to spawn naturally" and, "it is desirable to seek more beneficial ways of spending approximately 70 percent of the funds available for development and maintenance of stocks."

Several interesting illustrations in the book add emphasis to the text. The pictures of streams and lake types are of interest for comparison with streams and lakes in California coastal and valley districts.

The book is divided into four parts: Part I—Historical; Part II—Recent management of fisheries in New Zealand; Part III—Recent investigational work on fisheries management in other countries; Part IV—Future management and development of fisheries.

As the author points out, much data are lacking to warrant certain conclusions. He has, however, made use of all available information. Among other things he shows that the production of streams of New Zealand in terms of pounds of trout produced is as great today as it was when the fishery first began over seventy years ago.

His careful analysis of data at hand is worthy of imitation. Those persons interested in trout fishery management will find "Trout Fisheries in New Zealand" of decided interest and a definite help in the solution of their own problems.—*Harry A. Hanson, California Division of Fish and Game.*

Trapping

By Harold McCracken and Harry Van Cleve, A. S. Barnes Company, New York, 1947, 196 pp., $2.75.

This is a small but comprehensive volume dealing with life history, habits and range of the different furbearing animals of North America and methods of their capture. It should prove to be a valuable reference, especially for beginners, and perhaps many trappers who have not thoroughly learned the art of trapsetting. However as pointed out by the authors "Whether you are trapping amid the snow and ice of Alaska or the marshlands of Louisiana the most important requirement for successful trapping is to have a thorough knowledge of the animal sought. The trapper must be a naturalist as well as an expert in the art of setting traps. The printed page can only be an elementary guide and real knowledge comes only from first hand experience."

The authors apparently consider the fox to be one of the most difficult to trap inasmuch as they seem to stress the fact that in order to catch him the traps should be free from all oil, grease and human or domestic odors. In order to accomplish this the traps should be boiled in a solution made by boiling the bark from different trees, branches from shrubs or black walnut hulls. Foxes in the northern country and perhaps in the east may be hard to catch but in California our predatory animal trappers have difficulty in keeping a fox out of their traps. However it is heartily agreed that traps should be kept clean and free from all odor if the trapper

expects to attain a maximum of success. This especially applies to traps used for trapping the coyote.

Under the heading of "Wolf Blood" the authors tell of the advisibility of having wolf blood in the different breeds of sled dogs, the reason being that the work of a sled dog is mighty tough and there are exceedingly few breeds of dog that can stand it. Their feet are usually the first part to give out. I agree on all this but they then go on to tell us that the reason the dogs feet give out is because icicles have a habit of forming on the long hairs between the eyes causing him to go lame. No doubt this is a misprint but if not it is a new one on me. I never would have thought to look for icicles between a dog's eyes to locate the cause for lameness. Or should I?

Anyhow it is a good little book and is well worth the price to any young man who intends spending even part of his time at the business of trapping. From cover to cover it is interesting and contains much valuable information including hints and kinks for the outdoorsman.—*J. R. Wallace, California Division of Fish and Game.*

The Ruffed Grouse

By Frank C. Edminster. New York, The Macmillan Company, 1947, 385 plus xxvi pp., 28 line cuts, 157 photographs, $5.

The author has made available to ornithologists and game managers a wealth of information concerning this popular game bird. One must marvel in the adaptability of this species for this elusive and wary bird (during hunting season) was commonly called "fool hen" not many years ago. It's amazing and complex courtship activities are well known and the cause or causes of periodic population fluctuation has been a point of argumentation among orinthologists for several decades. The author has summarized all of the proposed theories affecting periodic fluctuations and states that, "These fluctuations are not sufficiently regular to be caused directly by some all-pervading common cause. They are inconsistent geographically, both in time of occurrence and severity of action." He completes this discourse with a statement that there is still much to learn about the subject.

Life history, ecology, and applied management are well covered in a text which is usable to a high degree. The author had seven years of experience in working with this species while serving with the New York State Conservation Department, and nine years of subsequent wildlife work with the U. S. Soil Conservation Service which has greatly broadened the scope of his research. References are liberally cited and an excellent detailed bibliography accompanies the text. The illustrations are excellent but it is felt that they should have been used throughout the text where applicable rather than being concentrated in one section.

The final chapter, "Management of the Ruffed Grouse," is logical in its presentation and should prove of value to game managers working with this species. This should be a basic text for reference work for many years.—*Henry A. Hjersman, California Division of Fish and Game.*

The Ruffed Grouse

By Henry Marion Hall; illustrated by Ralph Ray. New York, Oxford University Press, 1946. 91 pp., 8 col. pls., 10 figs. $6.50.

This companion book to "Woodcock Ways," by the same author, is well bound but the colored plates lack in authenticity. The text is of narrative style which makes for ease of reading, despite the wealth of information contained. Although Mr. Hall describes management practices in regard to this species, the book is intended for the sportsman and casual reader rather than the game manager or biologist. He does cover the gunning of ruffed grouse quite thoroughly especially in regard to guessing the direction of flight, forcing the flight, and conditions under which fast shooting is required.

This is recommended reading for the sportsman but interesting to anyone who enjoys days in the woods.—*Henry A. Hjersman, California Division of Fish and Game.*

Big Game Hunting

By Elmer Keith; illustrations by Bob Kuhn and author. Boston, Little, Brown and Company, 1948, 420 pp., photographs, $7.50.

Keith's lifetime experience as a big game hunter, guide and outfitter made it possible for him to test his many theories concerning rifles and loads. His writings of these experiences and his hunting methods make entertaining reading for all interested in big game hunting.

The book is well arranged and indexed. There is a separate chapter on the hunting of each of the big game mammals of North America.

The opening chapter titled, "How to Look for Game," is an original and well presented thesis on an important but seldom discussed part of big game hunting.

The author assumes that the hunter will be guided and outfitted by professionals. The chapter on "Pack Outfits and Tentage" and "Equipment" are written with this viewpoint reducing its value to independent hunters.

Keith has very definite opinions on the efficiency of various rifles for big game hunting. He reports on the performance of a number of "wildcat" and foreign rifles but neglects some of the most popular rifles of commercial United States manufacture.

Deer are not given a place in this book commensurate with the number of sportsmen that hunt deer as their only big game.—*James D. Stokes, California Division of Fish and Game.*

Shots at Whitetails

By Lawrence R. Koller, drawings by Bob Kuhn. Boston, Little, Brown and Company, 1948, 359 + vii pp., photographs, illus. and index, $5.

Koller is evidently well qualified to write on the subject of whitetail deer hunting. Although the title would indicate that this book is composed of a number of hunting anecdotes, this is not the case. The book covers the sport of whitetail hunting in detail, from the first chapter on the whitetail's natural history through hunting methods, choice of weapons and loads, preparation of meat for the table to mounting of the trophy head.

Outstanding is the author's inclusion of advice to the beginner, the unattached city hunter, and hunter of moderate means, as well as to the club and private reserve hunters.

The methods of hunting described have been used successfully by the author. He has steered clear of the common superstitions of the so-called "old-timer."

While this book covers very thoroughly its subject, it must be remembered that it deals with one species of deer, the whitetail, and one section of North America, New York State. Thus many of the hunting methods and the method of handling and aging the venison cannot be used in the West.—*James D. Stokes, California Division of Fish and Game.*

Wildlife Management: Upland Game and General Principles

By Reuben Edwin Trippensee, McGraw-Hill Book Co., New York, 1948, x + 479 pp., 36 figs., 71 tables, $5.

There is a growing demand for classroom texts summarizing the diverse and scattered recent literature in the wildlife field. Trippensee's *Wildlife Management* is a step toward filling this need.

The first 24 chapters are arranged in three main parts—Farm, Forest and Wilderness Wildlife. Each part is introduced by a chapter on general considerations in management, followed by detailed discussion of individual species or groups of related species. The remaining seven chapters of the book (there are 31 in all) cover Miscellaneous Wildlife Relationships and Wildlife Administration. Fur-bearers and waterfowl are not treated in this book, but they will be the subject of a companion volume to be issued later.

The book has real value to a beginning wildlife student in assembling for convenient reference a considerable volume of information about several dozen important game species. Some of the compilations are well done, particularly those concerning eastern species on which the author himself has worked, as for example the cottontail. Food habits of many species are treated exhaustively, and most essential facts of life history, ecology and management are included. The value of the book is such that it has been adopted by the reviewer as the beginning text in wildlife management at the University of California.

At the same time there is much to criticize in the volume. Many important western species are only sketchily covered. Frequently data are offered with little critical analysis or synthesis. Numerous important papers that appeared after 1940 are completely overlooked, and the whole point of view is rather that of the "food patch" era of game management which characterized the 1930's. Ideas of the last decade on population phenomena (sex and age composition, turnover and productivity rates, etc.) are scarcely acknowledged. A chapter on disease (by E. C. O'Roke) mentions only in passing the ecological aspects of disease in wild populations but devotes pages to the symptoms and cures of game farm maladies—hardly an up-to-date treatment.

Some of the range maps are grossly inaccurate. Pheasants in California, for example, are shown in the extreme northern counties and their presence is not acknowledged in the Central Valley (where the 1948 kill probably exceeded half a million birds). Gambel quail are shown over all of Southern California including the coast from Santa Barbara to San Diego. Two large blocks of bobwhite range are indicated in Northern California. And so on. All of the maps were taken from other publications, but this does not absolve Trippensee from his responsibility for reasonable accuracy, particularly when distribution data can be obtained with very little effort.

With all its shortcomings, *Wildlife Management* will serve a good purpose as a general reference book for wildlife beginners, though it is not of a caliber to become a classic in the technical literature.—*A. Starker Leopold, Museum of Vertebrate Zoology, University of California.*

Know Your Ducks and Geese

By Angus H. Shortt and B. W. Cartwright. Sports Afield Publ. Co., Minneapolis, 1948, 85.

This is the Sports Afield collection of know your ducks and geese. This series started to run in *Sports Afield Magazine* in January, 1946. One species appeared each month through three full years. The editors of the magazine have brought together all of these excellent paintings into one volume, beautifully bound, pages 11¾ inches by 14 inches. Thirty-six speci s of waterfowl are treated, a full page painting of each is presented preceded by a tissue sheet giving pertinent data on the species. The color pictures show the ducks in full nuptial plumage. The text on the tissue sheets carries black and white sketches of the birds on the water and a map showing the known distribution in North America.

This edition is dedicated to waterfowlers everywhere. It would make an excellent addition to the library of every student of waterfowl as well as sportsmen. The editors of *Sports Afield* Magazine are to be commended for making this excellent collection available to the public at such low cost.—*Carlton M. Herman, California Division of Fish and Game.*

REPORTS

SEIZURES OF FISH AND GAME

January, February, March, 1949

Fish:	
Abalone	1,165
Crabs	43
B. Bass	53
Bass	25
Catfish	16
Steelhead	11
Clams	2,500
Cockles	7,511
Lobsters	135
Lobsters, pounds	213
Salmon	2
Mullet	5
Sunfish	58
Skipjack, pounds	3,747
Sardines, pounds	128,500
Game:	
Coots	4
Deer	28
Deer meat, pounds	366
Doves	4
Ducks	895
Geese	34
Grouse	2
Shorebirds	4
Pheasants	47
Nongame	70
Pigeons	56
Squirrels	3
Quail	24
Rabbits	29
Swans	24
Sea Otter skins	2
Beaver skins	4
Muskrat skins	38
Mink skins	4

FISH CASES

January, February, March, 1949

Offense	Number arrests	Fines	Jail sentences (days)
Abalone: Overlimit; undersize; out of shell; closed season	87	$2,160 00	34
Angling: Closed stream; set lines; at night; possession gaff 300′ of stream	176	2,273 00	52½
Chum: Salmon eggs	1	50 00	
Mullet: Illegal nets	3	250 00	
Bass: Undersize; overlimit; at night; 2 rods	29	568 00	
Crabs: Undersize	3	75 00	
Clams: Undersize; overlimit	165	3,817 00	
Commercial: Round haul, dist. 20; no party boat license; resist arrest; illegal gill nets	37	1,360 00	15
Pollution: Oil; fish refuse	12	1,000 00	
Salmon: Snagging; gaffing; spawning beds	4	200 00	
Trout: Closed season	6	25 00	
Cockles: Overlimit; undersize	28	670 00	
Licenses: Transfer; back dating; false statement	8	115 00	
Sardines: Undersize	7	100 00	
Lobsters: Undersize; traps in closed district	13	1,085 00	
Catfish: Fyke nets	7	288 00	
Skipjack: Undersize	1	150 00	
Steelhead: Closed season; other than hook and line	2	250 00	
Sunfish: Overlimit	1	25 00	
Totals	589 590	$14,461 00	101½

Court Forfeitures

Undersize mackerel and sardines	$11,001 39

GAME CASES

January, February, March, 1949

Offense	Number arrests	Fines	Jail sentences (days)
Coots: Closed season	2		3
Deer: Doe; spike buck; taking in refuge; no tag; spotlighting	67	$6,146 00	262
Deer meat: Closed season; unstamped	28	3,400 00	350
Doves: Closed season; illegal import	3	105 00	
Squirrels: Closed season	4	200 00	
Ducks: Offer for sale; purchase; closed season	252	13,150 00	50
Geese: Closed season; overlimit	13	415 00	
Pheasant: Hen	28	2,475 00	74
Nongame: Possession	17	512 00	
Grouse: Possession	2	275 00	
Pigeons: Closed season	16	580 00	
Quail: Closed season	5	90 00	
Rabbits: Closed season	37	1,021 00	10
Shorebirds: Killing	4	85 00	
Swans: Possession	22	1,400 00	
Hunting: Unplugged gun; from highway; powerboat	270	6,605 00	
Sea otter: Skins, possession	1	100 00	
Beaver and Mink: Hides, illegal possession	1		
Totals	772	$36,559 00	772 749

7140 4-49 6M

ANNOUNCEMENT OF RECENT PUBLICATIONS

Fish Bulletin No. 68 (1948), Common Marine Fishes of California. By Phil M. Roedel. 150 pp. 111 figs.

Fish Bulletin No. 69 (1948), Age and Length Composition of the Sardine Catch Off the Pacific Coast of the United States and Canada, 1941-42 Through 1946-47. By Frances E. Felin and Julius B. Phillips. 122 pp.

Fish Bulletin No. 70 (1948), A Preliminary Population Study of the Yellowfin Tuna and the Albacore. By H. C. Godsil. 90 pp. 22 figs.

Fish Bulletin No. 71 (1948), Growth of the Sardine (Sardinops caerulea), 1941-42 Through 1946-47. By Julius B. Phillips. 33 pp. 12 figs.

Fish Bulletin No. 72 (1948), Trawling Gear in California. By W. L. Scofield. 60 pp. 24 figs.

Fish Bulletin No. 73 (1949), Tagging Experiments on the Pacific Mackerel (Pneumatophorus diego). By Donald H. Fry, Jr., and Phil M. Roedel. 64 pp. 15 figs.

These six publications are available to interested persons by request.

Write to:

DIVISION OF FISH AND GAME
California State Fisheries Laboratory
Terminal Island, California