CALIFORNIA FISH AND GAME

"CONSERVATION OF WILDLIFE THROUGH EDUCATION"

VOLUME 59 JULY 1973 NUMBER 3

California Fish and Game is a journal devoted to the conservation of wildlife. If its contents are reproduced elsewhere, the authors and the California Department of Fish and Game would appreciate being acknowledged.

The free mailing list is limited by budgetary considerations to persons who can make professional use of the material and to libraries, scientific institutions, and conservation agencies. Individuals must state their affiliation and position when submitting their applications. Subscriptions must be renewed annually by returning the postcard enclosed with each October issue. Subscribers are asked to report changes in address without delay.

Please direct correspondence, except regarding paid subscriptions, to:

CAROL M. FERREL, Editor
California Fish and Game
987 Jedsmith Drive
Sacramento, California 95819

Individuals and organizations who do not qualify for the free mailing list may subscribe at a rate of $2 per year or obtain individual issues for $0.75 per copy by placing their orders with the Office of Procurement, Documents Section, P.O. Box 20191, Sacramento, California 95820. Money orders or checks should be made out to Office of Procurement, Documents Section. Inquiries regarding paid subscriptions should be directed to the Office of Procurement.

CALIFORNIA FISH AND GAME

VOLUME 59 JULY 1973 NUMBER 3

Published Quarterly by

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME

CONTENTS

Calif. Fish and Game 59(3): 161–167. 1973.

SUSCEPTIBILITY AND RESISTANCE OF PHEASANTS, STARLINGS, AND QUAIL TO THREE RESPIRATORY DISEASES OF CHICKENS[1]

J. N. ALLRED [2], L. G. RAGGI and G. G. LEE

Department of Epidemiology and Preventive Medicine,
University of California, Davis, California

Ring-neck pheasants (*Phasianus colchicus torquatus*), starlings (*Sturnus vulgaris*) and valley quail (*Lophortyx californica*) are among the common avian species that inhabit the Central Valley of California and frequently can be seen in proximity to poultry houses. Since a large segment of the poultry industry is located in this area, an attempt was made to investigate the role played by these species in the epidemiology of three common diseases of chickens by determining their susceptibility to infectious laryngotracheitis virus (ILTV), infectious bronchitis virus (IBV) and *Mycoplasma gallisepticum* (MG).

INTRODUCTION

A review of the literature indicates that pheasants are susceptible to ILTV and MG (Beach 1931; Biester and Schwarte 1965; Hudson and Beaudette 1932; Jordan 1966; and Van Roekel 1955). Two species of quail are susceptible to IBV, i.e., European quail (*Coturnix coturnix*) (Biondi and Schirvo 1966) and Japanese quail (*Coturnix coturnix japonica*) (Edgar and Waggoner 1964) and a third species, bobwhite quail (*Collinus virginianus*), was found susceptible to MG (Madden, Henderson, and Moses 1967). Starlings and quail are reported (Biester and Schwarte 1965) resistant to ILTV. It has been over 30 years since the report on ILTV was published and we felt it advisable to repeat this work.

MATERIALS AND METHODS

Inocula

The ILTV used was the 151st egg passage of a commercial vaccine strain. It is still highly pathogenic for chickens. The ILTV was stored as a suspension of ground chorioallantoic membrane (CAM) in allantoic fluid (AF) in sealed ampules at —70 C and at time of inoculation had a 50% embryo plaque-forming units ($EPFU_{50}$) of 10^5 per ml. The inoculum consisted of a 1:5 dilution of this suspension in tryptose broth (Difco).

The IBV used was the Massachusetts strain with a 50% embryo infec-

[1] Submitted for publication January 1973.

[2] Partial requirement for Master of Preventive Veterinary Medicine degree. Present address: Veterinary Services, Animal and Plant Health Inspection Service, USDA, Hyattsville, Maryland.

tive dose (EID_{50}) of $10^{6.2}$ per ml. The inoculum consisted of a 1:5 dilution of AF in tryptose broth. The virus used for the serum neutralization (SN) test was the egg-adapted DA strain with a 50% embryo lethal dose (ELD_{50}) varying between 10^6 and 10^7.

The MG consisted of a broth (Difco PPLO) culture containing 10^9 viable organisms per ml.

Hosts

The pheasants were obtained from a hatching and brooding unit operated by the California State Fish and Game Department. Adult starlings were trapped by the Vertebrate Ecology Laboratory, University of California at Davis (UCD) and had been in captivity for several months. The quail were purchased from a commercial quail breeding farm in the lower Central Valley of California.

Eggs

Embryonating chicken eggs used for virus isolation and SN testing were obtained from the Experimental Animal Resources (EAR), UCD.

Housing of Experimental Birds

The pheasants used for ILT in lot 3 (Table 2) and quail for IB studies were housed in the maximum isolation building of EAR. In all other studies the birds were kept in wire cages under open sheds with metal roofs. The sheds were in an open field 200 ft apart and were cleaned and disinfected between experiments. Birds were fed a commercial chicken growing ration containing 27% protein.

Virus Isolation and Serology

Virus isolation in embryonating eggs was conducted as outlined in Methods for the Examination of Poultry Biologics (National Academy of Science, 1963).

The SN procedures used were those of Fabricant (1951) and Cunningham (1957).

The Spearman-Kärber method for estimating equivalent doses (ED_{50}) was used (Finney 1964).

The serum plate agglutination test using S_6 antigen, serial AJD-27 (H. E. Adler, UCD) was used for the MG tests.

Challenge Procedure

The surviving pheasants inoculated with ILTV in lot 3 were challenged 21 days PI by an intratracheal injection of 0.2 ml of virus broth suspension containing 4×10^3 $EPFU_{50}$. Birds showing acute respiratory signs or death within 5 days were considered susceptible to challenge.

Experimental Plan

Infectious Laryngotracheitis

Adult pheasants (lot 2, Table 1) which had resisted an inoculation of IBV 4 weeks earlier, were inoculated IT with 0.1 ml of ILTV containing 10^4 $EPFU_{50}$ as a trial run to determine if they were susceptible to this virus. Following this experiment lot 3, consisting of 26 six-week-old pheasants, was placed in three $10'' \times 2' \times 3'$ metal cages. Cages 1 and 2 were about 6 inches apart and contained 10 birds each (eight inoculated and two uninoculated contact controls). Cage 3 was about 6 ft from cages 1 and 2 and contained six uninoculated controls. Each pheasant was inoculated intratracheally (IT) with 0.1 ml of virus broth suspension containing 2×10^3 $EPFU_{50}$. On days 1, 2, 3 and 4 post inoculation (PI) two birds were killed and portions of the trachea and larynx were fixed in 10% formalin, sectioned and stained with hematoxylin and eosin for histopathology, and the remainder used for virus isolation. All birds found dead were necropsied and portions of trachea were treated as above. Embryonating eggs that developed plaques on the CAM during virus isolation attempts were harvested, and the AF used for hemagglutination test and the CAM for histopathology. Four to six serial passages were made from eggs not showing plaques on initial inoculation. At 21 days PI the immunity of all surviving birds was challenged as indicated above.

TABLE 1. Responses of Pheasant, Quail and Starlings to Infectious Laryngotracheitis Virus

Species and lot		Age (months)	Dosage $EPFU_{50}$	Clinical symptoms	Virus isolations	Histo-pathology	Mortality*
Pheasant	2	12	10^4	+	+	+	7/8
Pheasant	3	1½	2×10^3	+	+	+	14/16
Quail	1	2	2×10^3	•	−	−	0/3
Starlings	2	12	2×10^3	−	−	−	0/22

* Numerator = number of birds died; denominator = number of birds inoculated.

Twenty-two starlings (Table 1) were inoculated IT with 0.2 ml ILTV containing 2×10^3 $EPFU_{50}$. They were observed daily for clinical signs and on days 2 and 6 PI two birds were killed for histopathology and virus isolation.

Infectious Bronchitis

All birds (Table 2) inoculated with IBV were bled for SN test at the time of inoculation and again at 21 days PI. The pheasants were bled from the wing vein or from the heart. The starlings and quail were bled from the jugular vein (Kerlin, 1964). Each bird was examined daily for respiratory signs by exercising and ascultation for tracheal rales. On the second, third and fourth day PI two birds were killed for virus isolation and histopathology of the trachea. Four to six serial passages were continued in embryonating eggs from each trachea before considering the sample negative for virus. Twenty-one young pheasants (lot 4, Table 2) were inoculated IT with 0.2 ml of IBV suspension containing 2×10^5 EID_{50}. In an adjoining wire cage nine pheasants of the same hatch were kept as uninoculated controls. These were also bled for SN tests as above.

Synergism Studies

The second lot of starlings was first inoculated with ILTV, 4 weeks later they were inoculated with MG and 2 weeks later, inoculated with IBV. The quail were first inoculated with IBV, 6 weeks later they were inoculated with ILTV and 3 weeks after the ILTV exposure they were inoculated with MG. Four pheasants were inoculated with MG and 2 weeks later with IBV in an attempt to see if synergism would occur.

Each bird inoculated with MG received approximately 0.25×10^9 MG organisms. The starlings were inoculated into the left abdominal air sac, the pheasants and quail intranasally and IT. Preinoculation and postinoculation agglutination tests (21 days PI) were made. The birds were killed and examined for air sacculitis at the second bleeding.

RESULTS

Tables 1, 2 and 3 summarize the results. A few additional remarks are made from our observations on ILT in pheasants.

TABLE 2. Responses of Pheasant, Quail and Starlings to Infectious Bronchitis Virus.

Species and lot		Age (months)	Number inoculated	Dosage EID_{50}	Clinical symptoms	Virus isolation	SN antibody response
Pheasant	1	8	9	10^5	–	–	–
Pheasant	2	12	12	10^5	–	–	–
Pheasant	4	1¼	21	2×10^5	–	–	–
Quail	1	1	11	0.5×10^5	±*	–	±†
Starlings	1	10	13	2.5×10^5	–	–	–
Starlings	2	12	16	2.5×10^5	–	–	–

* Bronchial rales for 2–3 days only.
† Nonspecific response (log NI = 1.5).

TABLE 3. Responses of Pheasants, Quail and Starlings to *Mycoplasma gallisepticum*.*

Species	Age (months)	Number inoculated	Clinical symptoms	Antibody response	Air sacculitis
Pheasant	1¾	4	1/4†	4/4	0/4
Quail	2½	2	0/2	0/2	0/2
Starlings	12	16	0/16	0/16	0/16

* Uniform dosage of 2.5×10^8 viable organism per bird.
† Numerator = number of birds showing response; denominator = number of birds inoculated.

Signs

Audible rales with a sneezing and flipping of the head to expel mucus appeared as early as the second day PI. Hofstad (1965) gave 2 to 4 days incubation for chickens. Dyspnea usually appeared on the third or fourth day, and death came less than 24 hr later. Typical "pump-handle" breathing was observed in two or three of the adult birds. Only four birds (16%) recovered after having developed dyspnea. A high mortality of 72% is recorded for a natural outbreak in chickens (Biester and Schwarte 1965).

Pathology

All birds autopsied after signs developed and hemorrhagic tracheitis, many with mucus casts that occluded the trachea, almost identical with that described in the chicken (Biester and Schwarte 1965).

Histopathology

A progressive desquamation of the tracheal mucosa commencing on the second day PI with almost complete sloughing by the fourth day was noted as compared with 6–7 days in the chicken (Mayor 1968; Van Der Heide, Chute, and O'Meara 1967). Typical type A (Cowdry) intranuclear inclusion bodies as described in chickens (Biester and Schwarte 1965; Mayor 1968; and Van Der Heide, Chute and O'Meara 1967) were observed on the fourth day PI.

Virus Isolation

Virus was isolated from the trachea on the second, third and fourth days PI. Isolations were made from an eye swab and laryngeal swab 14 days PI from one control and one convalescent bird respectively.

Contact Transmission and Immunity

Two of 16 pheasants in lot 3 survived the ILTV inoculation. These two birds developed acute respiratory signs and recovered. When challenged they again developed acute respiratory signs and recovered the second time. Of the four uninoculated contact birds only one developed detectable signs (eye lesions). When challenged three were resistant and one susceptible. Of the six controls, separated by 6 ft of space, four were challenged. All four were susceptible and three of them died.

Only one of the four pheasants showed clinical evidence of a respiratory infection with MG, i.e., slight dyspnea with audible rales and slight nasal discharge. No puffing of the sinus was noted.

The quail inoculated with IBV developed bronchial or tracheal rales which were audible by holding the bird to the ear on the third and fourth days PI. No other signs were detected. Virus isolation was not successful. The PI neutralizing index (NI) was insignificant on blood samples taken on the 28th and 35th day PI using four and five eggs per dilution and repeating the SN test 3 times.

DISCUSSION

The result reconfirms the earlier reports (Biester and Schwarte, 1965; Hudson and Beaudette, 1932; Jordan, 1966; and Kernohan, 1931) that pheasants are highly susceptible to ILTV. This work also indicates that ILT can be transmitted from pheasant to pheasant by direct contact and that the virus can persist for at least 14 days which was the longest period tested after inoculation in recovered birds. Additional work will be needed to determine if pheasants can become carriers or constitute a reservoir of ILT infection for chickens. Also it should be determined if ILTV can produce an outbreak of disease in wild and commercial flocks of pheasants.

M. gallisepticum elicited only a mild response in the ring-neck pheasants, but under certain conditions natural outbreaks of this disease do occur (Biester and Schwarte 1965; Keymer 1961).

This experiment did not produce conclusive evidence that valley quail are susceptible to the three agents used. Clinical signs were observed on the second and third days after IBV inoculation; however, the virus was not recovered and the post inoculation neutralizing indices were nonspecific.

Under the conditions of this experiment adult starlings were not susceptible to ILTV, IBV or MG.

It is interesting to note that pheasants, immunologically more closely related to chickens (Mainardi 1959), were the most susceptible to ILTV and MG.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the assistance of Mr. Merton N. Rosen and Mr. John Azevedo and the California Department of Fish and Game for providing the pheasants, and Dr. Robert G. Schwab, Animal Physiology, U.C.D., for providing the starlings.

SUMMARY

Both adult and young pheasants were found highly susceptible to intratracheal inoculation with ILTV.

Transmission of ILTV from inoculated to uninoculated pheasants occurred on direct contact. Acute conjunctivitis appeared in one of four contact controls while the other three showed no signs. Three, including the bird with conjunctivitis, of the four controls were immune to challenge. Transmission did not occur in birds separated by 6 ft.

Four 7-week-old pheasants gave a serological response to inoculation with MG, but only one showed clinical signs.

Both adult and young pheasants were found refractory to IBV.

Starlings were found refractory to ILTV, IBV and MG.

Mild clinical signs were noted in 6-week-old valley quail inoculated with IBV. Virus isolation was not successful and the results of the SN tests were nonspecific.

Valley quail were found resistant to ILTV and MG.

REFERENCES

Beach, J. R. 1931. A filterable virus the cause of infectious tracheitis of chickens, J. Exp. Med. 54 : 801–808.

Biester, H. E. and L. H. Schwarte. 1965. Diseases of poultry. Iowa State College Press, Ames, Iowa. 5th ed. 411–426. Hofstad, M.A. 1965, p. 605–632.

Biondi, E. and A. Schirvo. 1966. Investigations into the susceptibility of various small passerine birds to the virus of infectious bronchitis. Acta Med. Vet. 12(6) : 537–547.

Cunningham, C. H. 1957. Infectious bronchitis virus. Am. J. Vet. Res. 18(68) : 648–654.

Cunningham, C. H. 1963. Laboratory guide in virology. Burgess Publ. Co., Minneapolis, Minn. 5th ed. p. 8–13, 16–35, 66–68.

Edgar, S. A. and R. Waggoner. 1964. Pathogens of *Coturnix coturnix japonica.* Quail Quart. 2(2) : 11–14.

Fabricant, J. 1951. Studies on the diagnosis of Newcastle disease and infectious bronchitis. Cornell Vet. 41 : 68–80.

Finney, D. J. 1964. Statistical methods in biological assay. Hafner Publ. Co., New York, N.Y. 2nd ed. p. 515–553.

Hudson, C. P. and F. R. Beaudette. 1932. The susceptibility of pheasants and a pheasant bantam cross to the virus of infectious bronchitis. Cornell Vet. 22 : 70–74.

Jordan, F. T. W. 1966. A review of the literature on infectious laryngotracheitis. Avian Dis. 10 : 1–26.

Kerlin, R. E. 1964. Venipuncture of small birds. J. Am. Vet. Med. Ass. 144 : 870–874.

Kernohan, G. 1931. Infectious laryngotracheitis in pheasants. J. Am. Vet. Med. Ass. 78 : 553–555.

Keymer, L. F. 1961. Infectious sinusitis of pheasants and partridges. Vet. Rev. 73 : 1,034–1,038.

Madden, D. L., W. H. Henderson and H. E. Moses. 1967. Case Report: Isolation of *Mycoplasma gallisepticum* from bobwhite quail (*Colinus virginianus*). Avian Dis. 11 : 378–380.

Mainardi, D. 1959. Immunological distance among some gallinaceous birds. Nat-ture 184 : 913–914.

Mayor, V. Y. 1968. Histopathological aids to the diagnosis of certain poultry diseases. Vet. Bull. 38(5) : 273–285.

National Academy of Science. 1963. National Research Council Publication No. 1038. Methods for the examination of poultry biologics. Revised ed. p. 11–34, 60–79.

Van Der Heide, L., H. L. Chute and D. C. O'Meara. 1967. A comparative investigation of the cause of an experimental infection with infectious laryngo-tracheitis in chickens. Avian Dis. 11 : 149–153.

Van Roekel, H. 1955. Respiratory diseases of poultry. *In:* Advances in veterinary science. (C. A. Brandley and E. J. Jungherr, eds.) Acad. Press Inc., New York. 4th ed. p. 64–105.

Calif. Fish and Game 59(3): 168–177. 1973.

THE CALIFORNIA SABLEFISH FISHERY FOR THE PERIOD 1953–1969[1]

RICHARD H. PARRISH

Marine Resources Region
California Department of Fish and Game

This report on the California sablefish fishery from 1953 to 1969 updates Phillips and Imamura's (1954) report, which described the fishery from 1941 to 1952. The otter trawl sablefish catches remained quite stable (962,557 to 2,157,047 lb.) from 1953 to 1969. This was probably due to the small variation in fleet size and that sablefish is an incidental species in otter trawl landings. Sablefish catches by the longline fleet declined to a low of 147,275 lb. in 1963. In 1964 the longline catch showed a strong recovery apparently due to increased demand and the catch rose to a peak of 2,401,057 lb. in 1967 primarily because of an increase in the catch per delivery.

INTRODUCTION

Sablefish (*Anoplopoma fimbria*) are distributed from Baja California, Mexico to the Bering Sea in depths between shore and at least 700 fathoms.

Sablefish were caught commercially as early as 1879 when Lockington (1881) noted them in San Francisco fish markets. From 1916, when statistics were first recorded for the California fish catch, to 1952 annual sablefish catches fluctuated between 83,623 lb. in 1916 and 6.3 million lb. in 1945. Landings declined after 1945 and landings in 1946 and 1952 ranged from 902,110 lb. to 2.6 million lb. (Phillips and Imamura 1954).

An assessment of the condition of the California sablefish stocks for the years 1941 to 1952 was made by Phillips and Imamura (1954). They concluded from their analysis of fishing effort using the average annual pounds per delivery of longline vessels at the major landing ports of Eureka, Fort Bragg, and Monterey that no stock depletion existed and that the annual catch fluctuations were associated with demand.

The fishery from 1953 to 1969 and an assessment of the condition of the stocks are described in this report. The data from the major ports of Eureka, Fort Bragg, and Monterey are treated together in contrast to Phillips and Imamura's (1954) analyses by individual ports.

HISTORY OF THE FISHERY

The California sablefish catch has shown a long upward trend since catch statistics began in 1916. The trend line shows a peak during the depression (1935) when landings rose to 2.8 million lb. and sablefish livers brought a higher price than the rest of the fish. Market demand caused a surge in the landings to 6.2 million lb. in 1945 and landings have shown a sharp upwards trend from 1.8 million lb. in 1963 to 4.1 million lb. in 1969. (Figure 1). Phillips and Imamura (1954) suggested

[1] Accepted for publication February 1973.

that the annual fluctuations in the catch were associated with demand as they found a negative correlation of —0.73 between the cold storage holdings of sablefish at the beginning of the year and the catch for

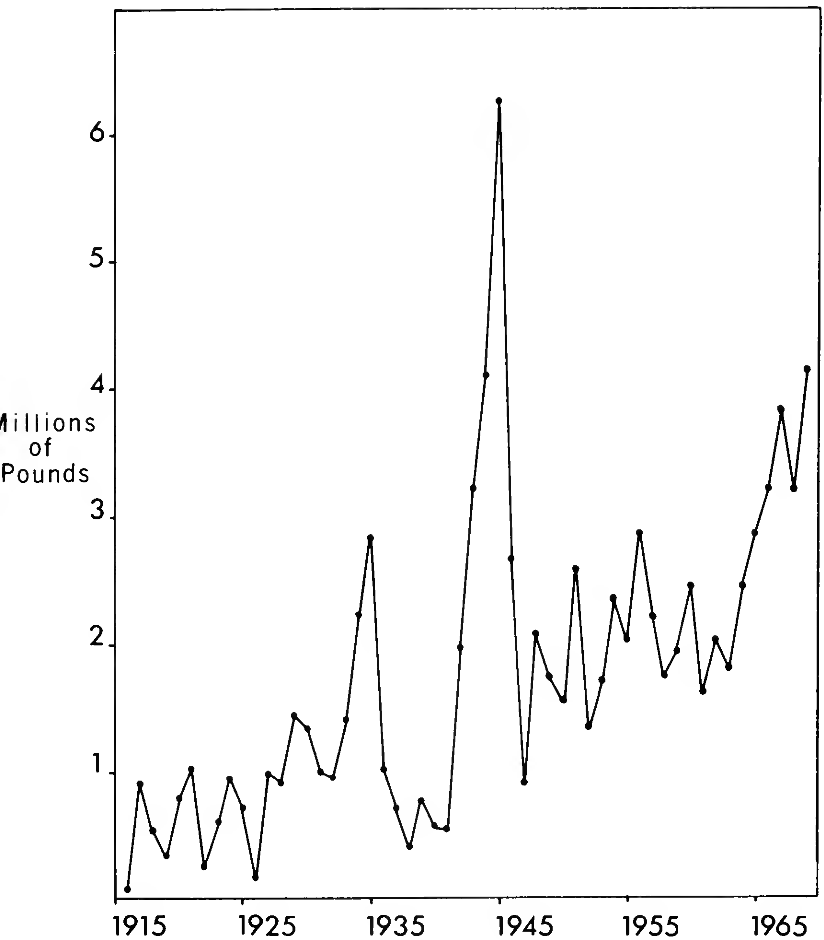

FIGURE 1. The California sablefish catch from 1916 to 1969

that year from 1946 to 1952. This situation has persisted through 1969; the correlation coefficient for the years 1946 to 1969 is —0.71, (Figure 2).

The limiting factor in the California sablefish landings has traditionally been market demand with the greatest demand for large fish, over 7 lb., which are marketed as "smoked cod." Sablefish are also known as blackcod or candlefish and the smaller fish are often filleted and marketed as butterfish. There is a large price difference with size. The large fish presently bring the fisherman from 12 to 14 cents per pound in the round. The price for medium fish, 5 to 7 lb., is 6.5 cents, while 4.5 to 5.5 cents per pound is paid for small fish under 5 lb.

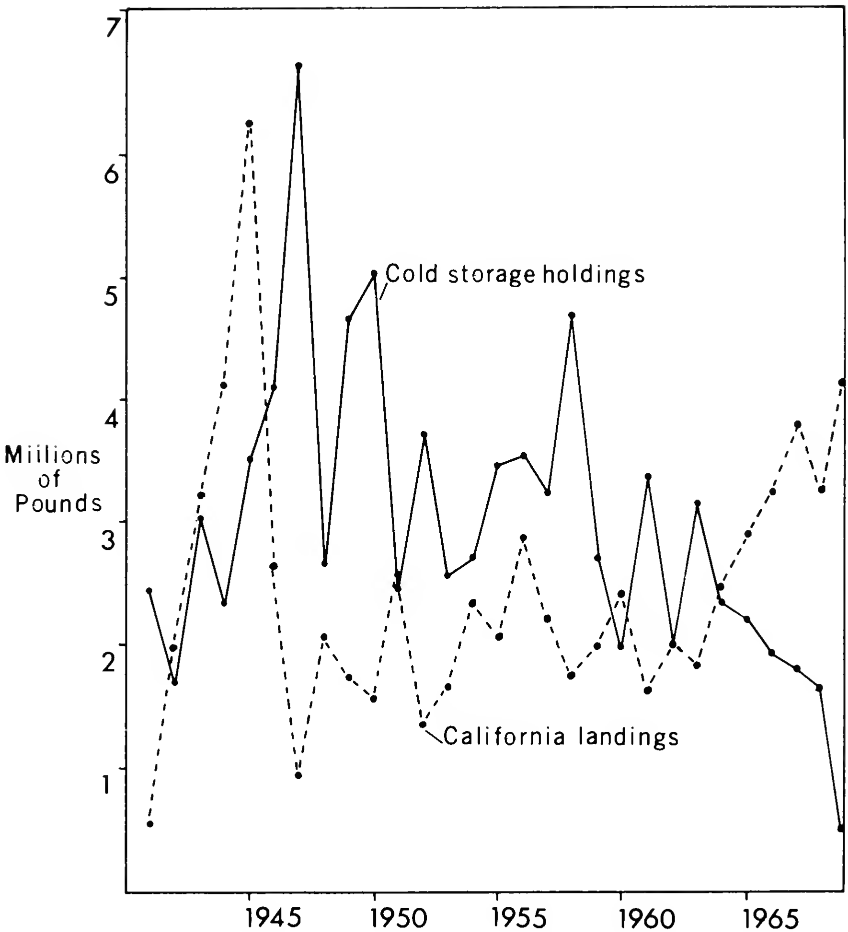

FIGURE 2. Cold storage holdings of sablefish on December 31 vs California landings for the subsequent year

Before 1943, sablefish were landed principally by a large fleet of small 2–3 man longline boats, the majority of which fished primarily for rockfish. (Phillips 1939). This "rockcod" fishery has nearly disappeared and the present small longline fleet expends the majority of its effort in relatively deep water 200–400 fathoms, fishing specifically for sablefish. The otter trawlers have accounted for approximately half of the sablefish landings since the rapid development of this fleet during the mid-forties. Sablefish are caught by otter trawlers during fishing operations for Dover sole, rex sole, petrale sole and rockfish. The trawl caught sablefish are smoked or filleted. Sablefish is also an important species in animal food landings of which they comprise up to 44% of the total.

The ports of Eureka, Fort Bragg, and Monterey have continued as major sablefish ports and San Francisco has had substantial sablefish

TABLE 1. **Total Annual Pounds of Sablefish Landed in Each Region in California During the Period 1953–1968.**

Year	Eureka	Fort Bragg	San Francisco	Monterey	Santa Barbara	Los Angeles	San Diego	State total
1953	553,689	285,120	222,109	588,182	1,670	4,653	---	1,655,423
1954	651,410	653,359	398,188	631,052	21,272	2,250	---	2,357,531
1955	490,976	552,142	345,482	615,871	52,487	7,666	439	2,065,063
1956	309,108	789,763	830,216	891,214	47,501	557	---	2,868,359
1957	432,423	938,345	425,486	379,955	23,473	100	---	2,199,782
1958	401,197	805,015	464,040	60,892	1,579	269	---	1,732,992
1959	451,387	706,280	698,991	67,961	13,183	554	---	1,938,356
1960	807,525	541,304	848,224	199.027	22,398	546	---	2,419,024
1961	286,723	293,176	672,640	350,409	12,643	937	---	1,616,528
1962	360,123	336,743	891,015	404,628	21,506	1,072	150	2,015,237
1963	457,372	180,565	840,564	271,226	57,436	1,838	348	1,809,349
1964	927,382	209,295	826,330	410,717	88,215	926	587	2,463,452
1965	891,574	663,394	683,292	570,905	53,140	1,245	---	2,863,550
1966	867,941	720,951	1,031,522	593,831	1,658	16	20	3,215,939
1967	997,789	1,302,788	474,786	1,021,201	1,610	---	319	3,798,493
1968	917,415	833,269	137,280	1,329,969	905	617	---	3,219,455
1969	1,513,911	914,655	208,252	1,517,590	1,385	230	823	4,156,846

TABLE 2. Annual Pounds of Sablefish Landed by Major Gear Type in the Eureka, Fort Bragg, San Francisco, and Monterey Regions of California.

Year	Eureka		Fort Bragg		San Francisco		Monterey		Total	
	Longline	Otter trawl	Longline	Otter trawl	Longline	Otter trawl	Longline	Otter trawl	Longline	Otter trawl
1953	215,077	338,612	110,555	174,565	---	222,109	360,911	227,271	686,543	962,557
1954	340,345	311,065	176,909	476,450	---	398,188	389,944	241,108	907,198	1,426,811
1955	226,872	264,104	217,454	334,688	---	346,047	342,610	273,221	786,936	1,218,060
1956	64,736	244,302	452,776	336,987	---	830,158	327,250	563,964	844,762	1,975,411
1957	186,037	246,386	538,676	399,669	2,138	423,384	204,759	175,196	931,610	1,244,635
1958	156,794	244,293	140,035	664,941	327	463,618	19,831	40,886	316,987	1,413,738
1959	79,993	371,394	135,199	571,081	693	698,298	18,868	48,947	237,753	1,689,720
1960	39,373	768,152	118,443	422,861	143	847,858	127,861	71,166	285,820	2,110,037
1961	---	286,723	50,621	242,555	1,666	670,899	222,679	127,597	274,966	1,327,774
1962	26,202	333,912	77,088	259,655	---	890,965	220,614	183,141	323,904	1,667,673
1963	54,069	403,271	9,502	171,063	168	840,223	83,536	187,600	147,275	1,602,157
1964	637,129	290,210	962	208,333	---	826,250	205,306	205,288	843,397	1,530,081
1965	364,504	527,070	326,629	336,765	---	683,292	169,073	401,722	860,206	1,948,849
1966	481,982	385,959	445,591	275,360	---	1,031,522	209,741	383,490	1,137,314	2,076,331
1967	590,736	407,053	1,066,417	236,371	2,839	471,516	741,065	279,061	2,401,057	1,394,001
1968	222,246	692,952	588,757	271,943	4,010	129,738	1,006,412	322,518	1,791,425	1,417,151
1969	238,109	1,275,802	429,564	475,105	---	207,395	1,312,163	198,745	1,979,836	2,157,047

landings since 1951. Landings by both longline vessels and otter trawlers are important at the first three ports but San Francisco's sablefish landings are almost exclusively landed by otter trawlers (Tables 1 and 2). Annual landings reported south of Monterey did not exceed 90,000 lb. during the period covered by this report.

CATCH ANALYSIS

The longline fleet has been declining and their landings show a downward trend from 3,868,678 lb. in 1945 to a low of 147,107 lb. in 1963 (Table 2). The size of the fleet fell from 192 boats in 1941 to 12 boats in 1963 (Figure 3). In 1964 the longline landings showed a strong comeback apparently due to the increased demand reflected in an increase in price of several cents per pound over the 1963 price. This comeback was achieved with very little increase in fleet size and was therefore the result of a relatively small number of fishermen who put forth considerable effort specifically upon sablefish. The average catch of sablefish by longliners was fairly constant over the fishery prior to 1964, with annual catches per boat usually occurring between

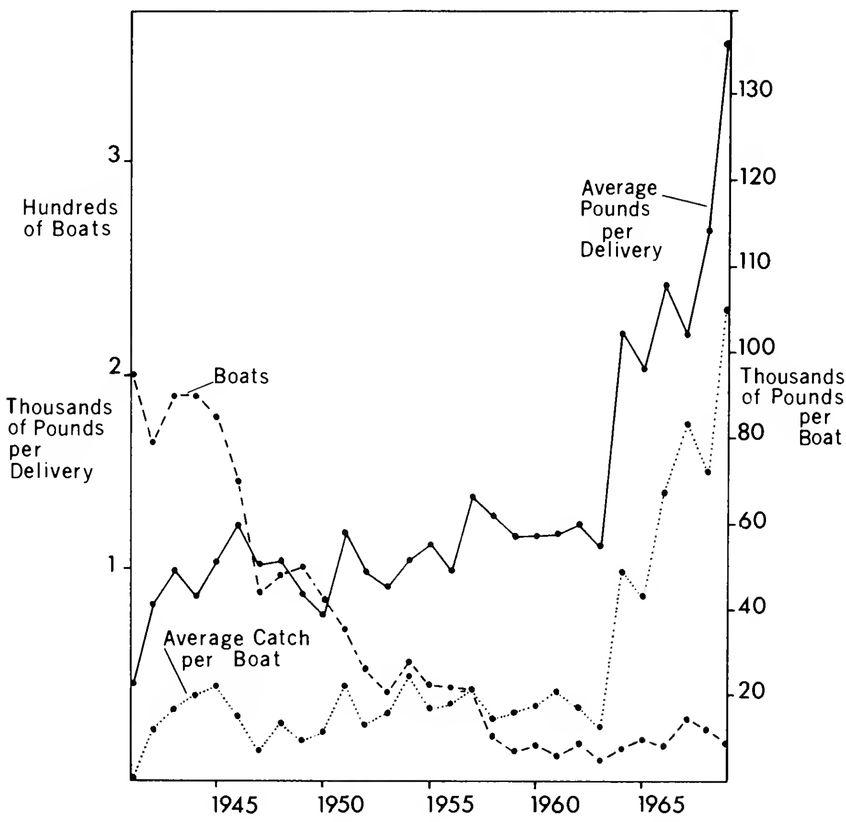

FIGURE 3. Annual California sablefish longline fleet size, average annual catch per boat, and average pounds per delivery

10,000 and 25,000 lb. The average annual catch per boat during the period of 1964 to 1969 was greatly increased over the earlier period and peaked at 110,452 lb. in 1969 (Figure 3).

A large increase in the average pounds per delivery occurred in the revitalized longline fishery. Before 1964 the average sablefish delivery by longliners stayed quite constant at around 1,000 to 1,200 lb. The largest average landing was in 1960, 1,458 lb. and the smallest average occurred in 1950, only 769 lb. per delivery.

Beginning with the 1964 season, the average delivery by longliners nearly doubled and has remained near 2,000 lb. from 1964 to 1968. In 1969 the catch per delivery rose to an all time high of 3,519 lb. (Figure

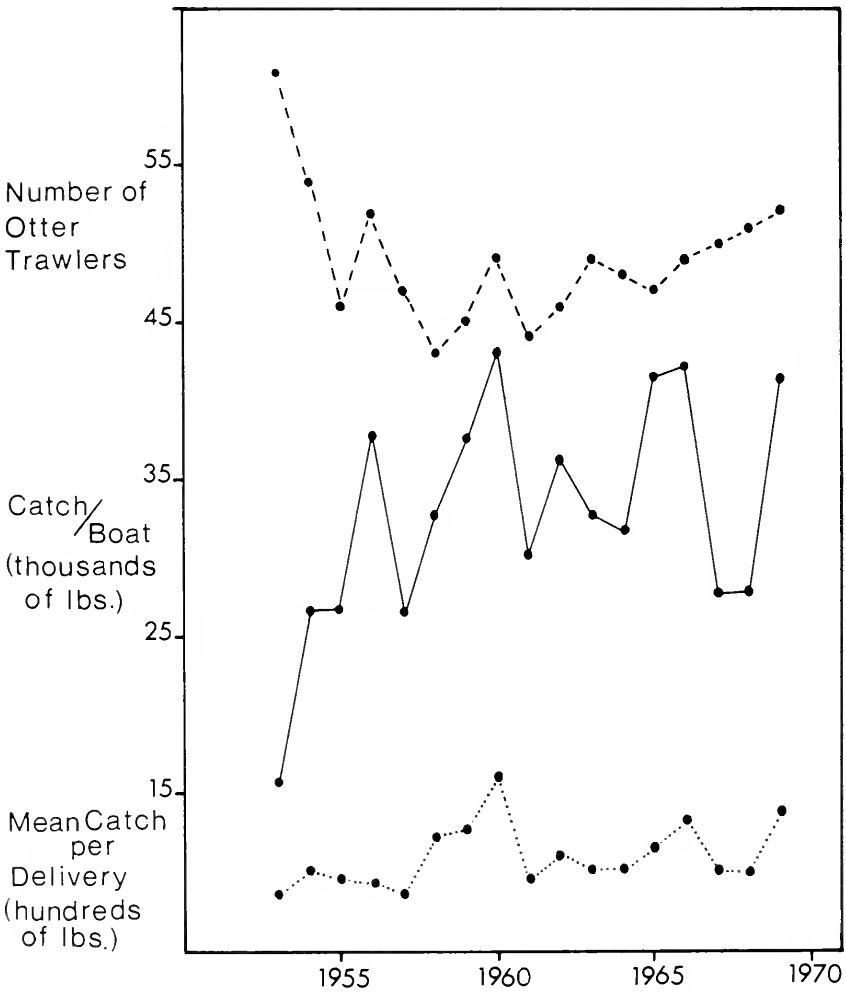

FIGURE 4. Annual California sablefish otter trawler fleet size, average annual catch per boat and average pounds per delivery

3). Two other factors may partially account for the large increase in the average delivery. In Eureka and Fort Bragg, the longliners have traditionally made 2 to 3-day trips to more distant and productive sablefish grounds when the market demand was high. The increased demand since 1964 may have resulted in an increase in the proportion of deliveries from these longer trips. In Monterey, where the longline fishery is essentially a day-boat operation, the increased demand has resulted in an increase in the number of "baskets" used per boat. Phillips and Imamura (1954) reported that the number of baskets

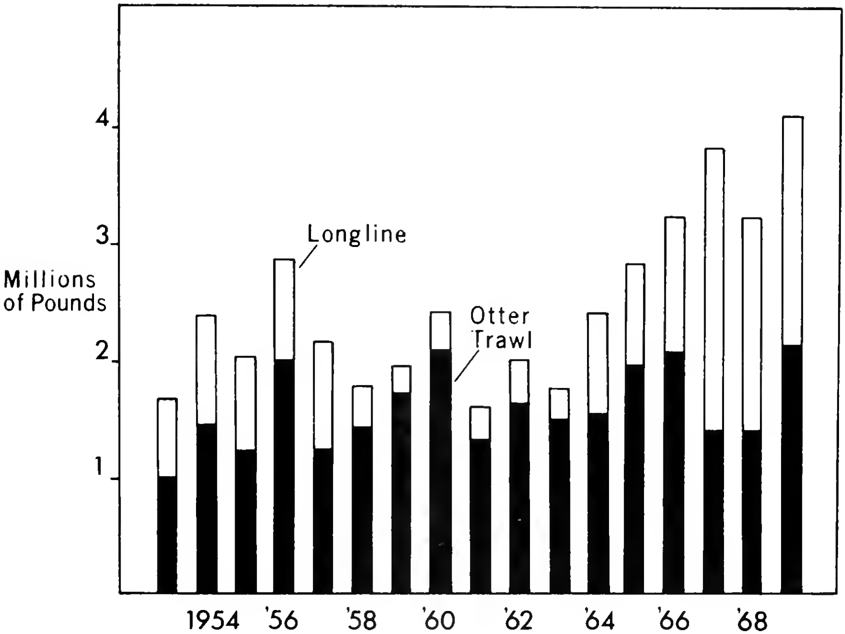

FIGURE 5. California sablefish landings from otter trawlers and longline vessels, 1953 to 1969

fished by a two-man crew was 10 to 15 a day. By 1969, the number of baskets used rose to 20 to 25 per day and three-man crews now normally set around 40 baskets per day. This increase in the number of baskets fished has forced many of the fishermen to coil and bait their gear on one day and fish the next day.

The lack of quantitative data on changes in fishing tactics, in gear units, or in efficiency of longline vessels prevents determining if the great increase in average pounds of sablefish per delivery is due partially to an increased availability of sablefish off California. It seems reasonable that tactics, the increase in gear units, and the decrease in the longline rockfish fishery have caused the bulk of the increase in catch per delivery.

The otter trawl sablefish fishery remained quite stable from 1953–1969, with the annual catch for the four major ports varying between 962,557 and 2,157,047 lb. with no obvious trends.

Annual catch by port showed considerably more relative variation than did the combined catch. Eureka landings varied from 244,293 to 1,275,802 lb. and otter trawl landings in the Monterey area varied between 40,886 and 563,964 lb. (Table 2).

Relative stability in the otter trawl landings was because sablefish are largely an incidental species in the otter trawl catch, and the nominal variation in the number of otter trawlers landing sablefish from 1954 to 1969 (43 to 54 boats). Mean sablefish catch per boat also showed little change (26,480 to 43,061 lb.). The 1953 season had a somewhat larger fleet landing sablefish (61) and a small (15,780) annual catch per boat (Figure 4). Mean catch per delivery showed little variation from 1953 to 1969 (849 to 1617 lb.). This suggests that the longline fleet catch has caused the recent increase in landings and the otter trawl fishery has been little affected by the increased demand for sablefish since 1964 (Figure 5). Sablefish are apparently not a significant enough factor in the total otter trawl fishery for the increased demand to cause a change in fishing tactics.

Sablefish is the dominant species in the California animal food trawl fishery. This fishery has been sampled for species composition since 1956 and sablefish have comprised up to 44.8% of the annual landings. Sablefish landings from the animal food fishery are not included in this analysis. The peak sablefish landings in the fishery occurred in 1960 when 1,194,459 lb. were landed (Table 3).

TABLE 3. **California Landings of Sablefish for Animal Food**

Year	Sablefish (lb.)	Percent of total	Year	Sablefish (lb.)	Percent of total
1953	Not sampled	---	1962	308,289	16.4
1954	Not sampled	---	1963	341,207	33.0
1955	Not sampled	---	1964	778,822	44.8
1956	341,965	23.0	1965	1,149,460	40.0
1957	582,982	38.0	1966	1,014,927	42.7
1958	726,724	23.7	1967	793,374	30.5
1959	658,040	18.8	1968	789,838	30.5
1960	1,194,459	29.8	1969	872,998	36.2
1961	1,057,579	28.0			

The only recent work which has analyzed the economics of the California fresh fish trade is O'Rourke and DeLoachs (1971). They hypothesized a model to describe the relationship between demand, prices, and the California catch of 12 of the most important species in the fresh fish landings. Sablefish was the only species for which they were unable to find a satisfactory fit to their model. A possible factor causing a poor fit for sablefish was that the longline fishery showed a response to increased demand for sablefish but the otter trawl fishery was not affected. Another factor was that they assumed that economic control of the fresh fish trade was primarily within California. This is not the case for sablefish, where imports from the Pacific northwest and Japan have been of considerable magnitude (490,990 lb. in 1960, Table 4).

TABLE 4. **Shipments of Sablefish Into California by Origin**

Year	Pacific NW (lb.)	Japan (lb.)	Year	Pacific NW (lb.)	Japan (lb.)
1953	459,109	---	1962	74,449	60,000
1954	447,387	---	1963	96,309	92,250
1955	452,470	---	1964	20,169	160,000
1956	493,132	---	1965	---	---
1957	255,613	---	1966	---	---
1958	224,674	---	1967	38,417	297,125
1959	301,041	---	1968	---	126,000
1960	490,990	---	1969	40,337	166,120
1961	246,054	168,000			

RECOMMENDATION

The increased demand for California sablefish since 1964 has resulted in a significant increase in the longline fishery for sablefish. Recently considerable interest has also been shown in a "pot" or trap fishery for sablefish. Present domestic exploitation of sablefish remains at a low rate; however, the effort on sablefish is restricted to a small proportion of the area inhabited by sablefish off California. This fact, plus the possible effects from the large foreign fishery on sablefish in the Pacific northwest, suggests that we should closely monitor this developing fishery.

REFERENCES

Lockington, W. N. 1881. Report upon the food fishes of San Francisco. Report of the Commissioner of Fisheries of the State of California for the years 1878 and 1879. p. 17–58.

O'Rourke, A. D. and D. B. DeLoach. 1971. The California fresh and frozen fishery trade. Calif. Agric. Exp. Sta. Bull. 850: 1–79.

Phillips, J. B. 1939. The rockfish of the Monterey wholesale markets. Calif. Fish Game 25 (3): 214–225.

Phillips, J. B. and Seigi Imamura. 1954. The sablefish fishery of California. Pac. Mar. Fish. Comm. Bull. 3: 5–38.

Calif. Fish and Game 59(3): 178–190. 1973.

CONTRIBUTIONS TO THE LIFE HISTORY OF THE SILVER SURFPERCH (*HYPERPROSOPON ELLIPTICUM*) FROM THE OREGON COAST[1]

RICHARD S. WYDOSKI[2] and DONALD E. BENNETT[3]

Oregon Cooperative Fishery Unit
OSU Marine Science Center
Newport, Oregon

The silver and redtail surfperches are the most common fish inhabiting the surf zone of northern California and Oregon. Data on the life history of the silver surfperch from the Oregon coast were collected between June 1967 and January 1969. This paper provides the first published information on the biology of this species and includes summaries of age and growth by sex, length-weight relationships, relation between age and size to sexual maturity, fecundity, and a parasite that is unique to surf-dwelling embiotocids. Females grow faster than males and this characteristic was related to reproductive maturity. Silver surfperch first become sexually mature in Age Group I. Males are ripe in late September when copulation occurs. Females give birth to their young between late June and early August. Fecundity of the females was related to their size with the smallest (174 mm TL) containing 4 embryos and the largest (221 mm TL) containing 17. The incidence of a monogenetic trematode (*Diclidophora* sp.) that is found only on the gills of surf-dwelling embiotocids is summarized by age and size of the fish.

INTRODUCTION

The silver surfperch, *Hyperprosopon ellipticum* (Gibbons), is distributed along the Pacific coast from southern California to Vancouver Island, British Columbia (Tarp 1952; Peden 1966). This surfperch primarily inhabits the sandy surf zone but is also found around rocky outcroppings and jetties and sometimes in the mouths of estuaries. In northern California, the redtail (*Amphistichus rhodoterus*) and the silver surfperches are the most common surf species (Miller and Gotshall 1965). These two species are also the most common surf inhabitants in Oregon and probably in Washington. Miller and Gotshall (1965) ranked the silver surfperch ninth by number in the entire sportfishery and third in the ocean sport catch of shore fishermen from the Oregon border to Point Arguello, California.

While studying the redtail surfperch from June 1967 through January 1969, we were able to obtain data on some aspects of the life history of the silver surfperch. The study area included Alsea and Yaquina bays and approximately 14 miles of the surf zone between these bays along the central coast of Oregon. The published literature on this species has been limited to taxonomy, distribution, description, and

[1] Accepted for publication January 1973. This research was conducted through the Oregon Cooperative Fishery Unit. Cooperating Agencies include the Bureau of Sport Fisheries and Wildlife, Oregon Game Commission, Fish Commission of Oregon, and Oregon State University.

[2] Present address: Washington Coop. Fishery Unit, Univ. Washington, Seattle.

[3] Present address: Fish Commission of Oregon, Clackamas, Oregon.

formation of keys. This paucity of information on the life history of surf-dwelling fish has been attributed to the difficulty in sampling this habitat (Schaefer 1967). This paper will describe aspects of the silver surfperch biology including the age and growth by sex, length-weight relationship, relation of age and size to sexual maturity, fecundity, and a parasite unique to surfdwelling embiotocids. The Bureau of Sport Fisheries and Wildlife (1959) and Stroud (1971) have emphasized the need for this kind of information in their reviews of the national research program of our marine sport fisheries.

METHODS AND MATERIALS

Sampling of the surf zone and estuaries was made at least once monthly using gill nets, dip nets, and hook-and-line. Most of the silver surfperch were captured from June through September. All fish were weighed, measured, and dissected within a few hours after capture. The fish were either brought back to the laboratory while alive or the females were placed in individual plastic bags to avoid the loss of embryos.

RESULTS AND DISCUSSION

Conversion Factors

Total length (TL) measurements are used for the various analyses in this paper. However, since many investigators have reported their

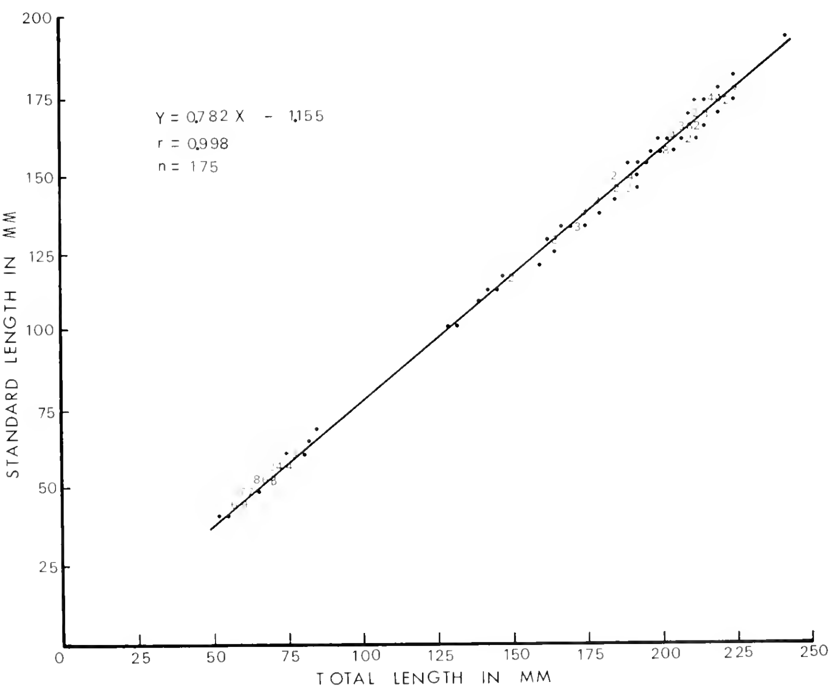

FIGURE 1. Regression of SL compared with TL for silver surfperch from the Oregon coast. (The numbers refer to overlapping points; the letters refer to 10 or more overlapping points with A = 10, B = 11, C = 12, etc.)

results on embiotocids using other measurements, we calculated equations to convert TL into standard (SL) and fork length (FL). Carlisle, Schott, and Abramson (1960) and Anderson and Bryan (1970) have reported that the tail length decreased with increased body lengths for four species of embiotocids. Our analysis of silver surfperch did not indicate a difference in this characteristic for fish between 40 and 242 mm TL (Figure 1). A similar relationship was found between FL and TL. The regression equation was $Y = 2.429 + 0.9004X$ with $r = 0.987$ for 211 fish, where X = TL in mm and Y = FL in mm.

Age and Growth

Age determination was made by the scale method. Other investigators (Carlisle et al. 1960; Wares 1968; Bennett and Wydoski (1971, Ms.) have found that the scale method was reliable for age determination in the Embiotocidae. To check the consistence of age assignments, we determined the ages separately and found that we agreed 91% of the time. The final age determinations were made by the senior author. Because of the high proportion of regenerated scales, the scale sample was taken from a key area of the body. This area was about four to eight scale rows below the lateral line and on an oblique from the origin of the dorsal fin.

The scales from silver surfperch were very thin and delicate. This characteristic was also observed in the walleye surfperch, *Hyperprosopon argenteum,* from California by Anderson and Bryan (1970) and from Oregon during the present study. All scales were, therefore, mounted in a glycerin-gelatin mounting medium (Lagler 1956) to avoid damage. Three checks were recognized from the structure of the scales: birth, spawning, and annulus checks. However, not all fish exhibited clear birth or spawning marks and some lacked these marks entirely. Birth checks varied from very evident to slight in silver surfperch and this check was not found in a few fish. Apparently some young surfperch can adapt more readily when they pass from ovarian fluid of the female to seawater at birth. Spawning checks contained circuli that were relatively continuous and, therefore, could be distinguished from true annuli. These checks were most easily recognized in the earlier years of life for females and were lacking from the scales as the female became older. This phenomenon was also noted in the redtail surfperch by the authors (Bennett and Wydoski Ms.) and perhaps can be explained because younger fish grow faster than older fish. Young females would begin to grow early in the spring when the embryos were small. As the embryos began to grow rapidly, the female's growth would be interrupted until birth occurred and then the female would resume her growth. The annulus and spawning checks would be superimposed in older females because little, if any, growth would occur in the female while the embryos were rapidly developing. True annuli could be recognized by the closer spacing of the circuli and by crossing over of circuli that could be traced entirely around the scale.

Because annuli were most evident along the anterio-lateral radius of the scale, scale measurements were made along this axis by using a Bausch and Lomb microprojector at a magnification of 47.74 X. The body-scale relationship for silver surperch was calculated by the method of least squares (Figure 2). The spread of points for scales from a key area was similar to that found for key scales in other embiotocids (Gordon, 1965; Wares, 1968). Back calculation of growth was made

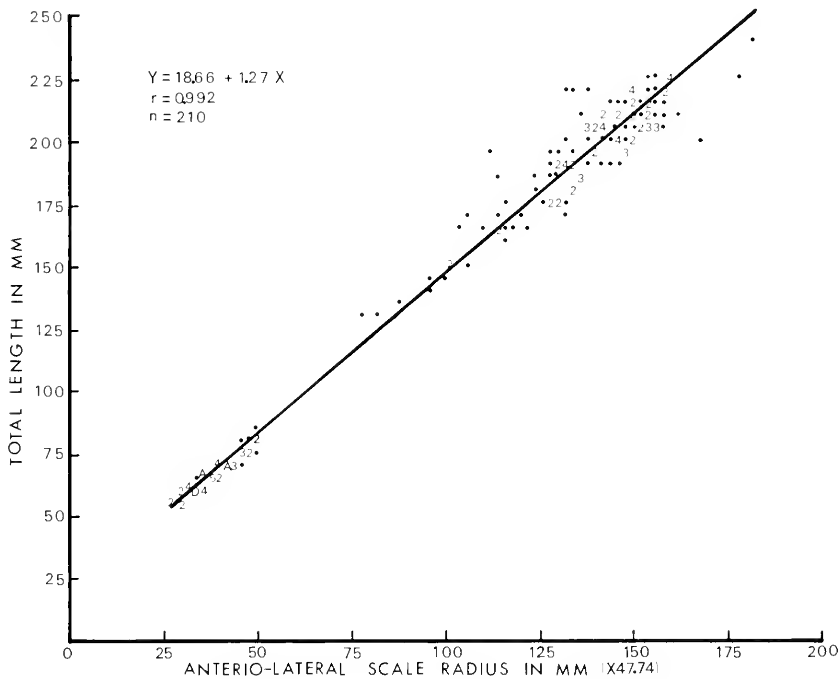

FIGURE 2. **Body-scale relationship for silver surfperch from the Oregon coast. (The numbers refer to overlapping points; the letters refer to 10 or more overlapping points with A = 10, B = 11, C = 12, etc.)**

by direct application of the body-scale regression equation (Table 1). Females were larger than males after the first annulus (Figure 3). This difference was related to sexual maturation in the silver surfperch. Faster growth in females has been found in other species of embiotocids: redtail surfperch (Bennett and Wydoski Ms.); barred surfperch, *Amphistichus argenteus,* (Carlisle et al. 1960); white seaperch, *Phanerodon furcatus,* shiner perch, *Cymatogaster aggregata,* and walleye surfperch (Anderson and Bryan 1970); pile perch, *Rhacochilus vacca,* (Wares 1968); and striped seaperch, *Embiotoca lateralis* (Sivalingam 1953). In one exception to this trend, Gnose (1968) reported that male striped seaperch in Oregon grew faster than females.

Because weight can be influenced by the amount of food in the stomach of a fish, different sampling periods, sample size, and other factors, a length-weight relationship was determined by combining all

TABLE 1. Calculated Lengths at the End of Each Year of Life for Silver Surfperch from the Oregon Coast.

Age group	Number of fish	Calculated total lengths at each annulus						
		1	2	3	4	5	6	7
(Males)								
I	6	106.5						
II	16	104.5	153.2					
III	10	105.1	147.7	170.4				
IV	26	107.6	145.8	169.5	188.4			
V	30	104.8	148.1	170.6	188.1	202.7		
VI	11	100.5	141.4	167.6	181.1	194.4	206.2	
VII	5	96.4	138.0	164.1	181.2	195.6	206.0	216.8
Average		103.6	146.2	168.4	184.7	197.6	206.1	216.8
Increment		103.6	42.6	22.2	16.4	12.9	8.5	10.7
Number		101	98	82	72	46	16	5
(Females)								
I	3	103.9						
II	10	102.0	153.5					
III	16	102.8	151.6	181.1				
IV	2	111.3	173.3	191.8	209.1			
V	1	110.7	179.7	198.9	218.1	237.2		
Average		106.1	164.5	190.6	213.6	237.2		
Increment		106.1	58.4	26.1	23.0	21.6		
Number		32	29	19	3	1		

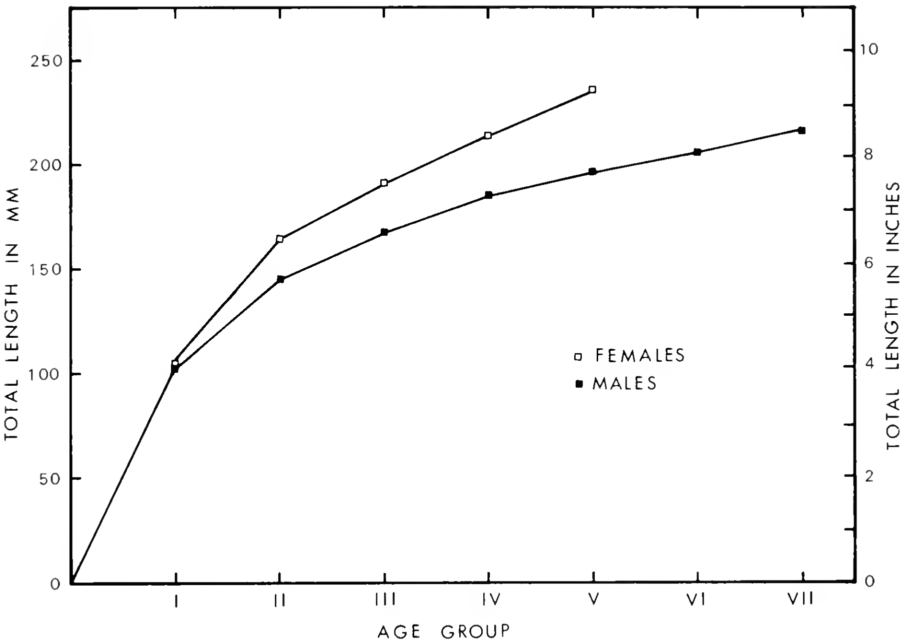

FIGURE 3. Calculated lengths at the end of each season of growth for silver surfperch from the Oregon coast.

data (Figure 4). Separate length-weight relationships were also calculated for males, females, and immature fish, as follows:

Sex	*Length-weight relationship*	*r*	*n*
Males	log Y = 3.131 log X —5.106	0.988	105
Females	log Y = 2.936 log X —4.669	0.983	32
Immatures	log Y = 3.148 log X —5.186	0.968	74

Where X = total length in mm, Y = weight in grams, r = correlation coefficient, and n = number of fish.

Relationship Between Age and Size to Sexual Maturity

Sexual maturity was determined by macroscopic examination of the gonads. Vascularization and enlargement of the testes from late June to early October were used as criteria for classifying the maturity of males. Immature males did not show any change in the morphology of their testes during this time. Females were judged sexually mature on the basis of their ovarian morphology. From late June to August spent females could be recognized by the enlarged and flaccid ovary. In immature females the ovary was small and firm.

Silver surfperch become sexually mature in Age Group I (Table 2). All fish of both sexes in Age Group III or older are mature. In general, a greater proportion of the larger individuals from Age Group I and II for males and from Age Group II for females were mature (Table

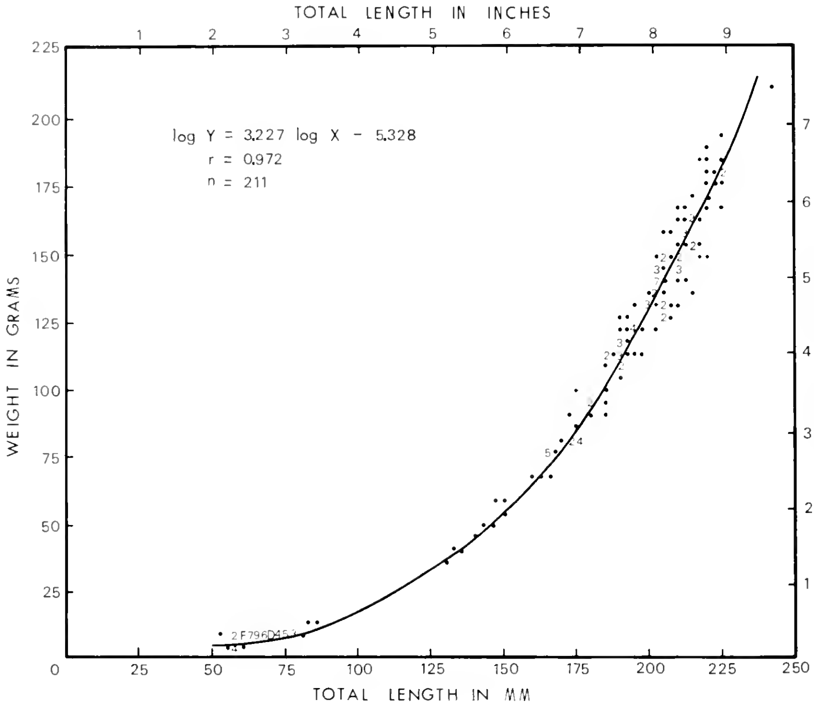

FIGURE 4. Length-weight relationship for silver surfperch from the Oregon coast. (The numbers refer to overlapping points; the letters refer to 10 or more overlapping points with A = 10, B = 11, C = 12, etc.)

2). Therefore, both size and age have an influence on maturity. This characteristic was more clearly demonstrated for the redtail surfperch where we had larger sample sizes (Bennett and Wydoski Ms.).

A maturity index (gonad weight × 100 divided by body weight) was calculated for males to show the annual development of the testes. All males that were longer than 160 mm TL were included in these calculations, because males longer than this length would probably be mature during the next mating season (Table 2). The gonads become vascularized and heavier until the end of July (Figure 5). After this time, spermatogenesis is well underway and on September 25, 1968 three males were captured that readily emitted milt. When the males were ripe the maturity index was only about one-fourth of the value

TABLE 2. **The Relationship Between Size and Age to Sexual Maturity in Silver Surfperch from the Oregon Coast.**

Total length (mm)	Age group															
	I		II		III		IV		V		VI		VII		Total	
	N	%M	N	%M	N	%M	N	%M	N	%M	N	%M	N	%M		
(Males)																
121–130	1	0													1	0
131–140	1	0													1	0
141–150	4	100													4	100
151–160			1	0											1	0
161–170			6	67											6	67
171–180			8	62											8	62
181–190			1	100	8	100	2	100							11	100
191–200					3	100	9	100	2	100					14	100
201–210							12	100	16	100	1	100			29	100
211–220									8	100	7	100			15	100
221–230									1	100	2	100	5	100	8	100
Total	6	66	16	62	11	100	23	100	27	100	10	100	5	100		
(Females)																
121–130	1	0													1	0
131–140	--	--													--	--
141–150	1	0													1	0
151–160	1	0													1	0
161–170			2	0											2	0
171–180			5	40											5	40
181–190			--	--	2	100									2	100
191–200			2	50	2	100									4	75
201–210			--	--	5	100	1	100							6	100
211–220			1	100	5	100	--	--							6	100
221–230					2	100	1	100							3	100
231–240															--	--
241–250									1	100					1	100
Total	3	0	10	40	16	100	2	100	1	100						

in July when the testes were heaviest (Figure 5). Testes develop in a similar manner in pile perch (Wares 1968) and in redtail surfperch (Bennett and Wydoski Ms.). Sperm was readily emitted between October and January by pile perch and in early January by redtail surfperch.

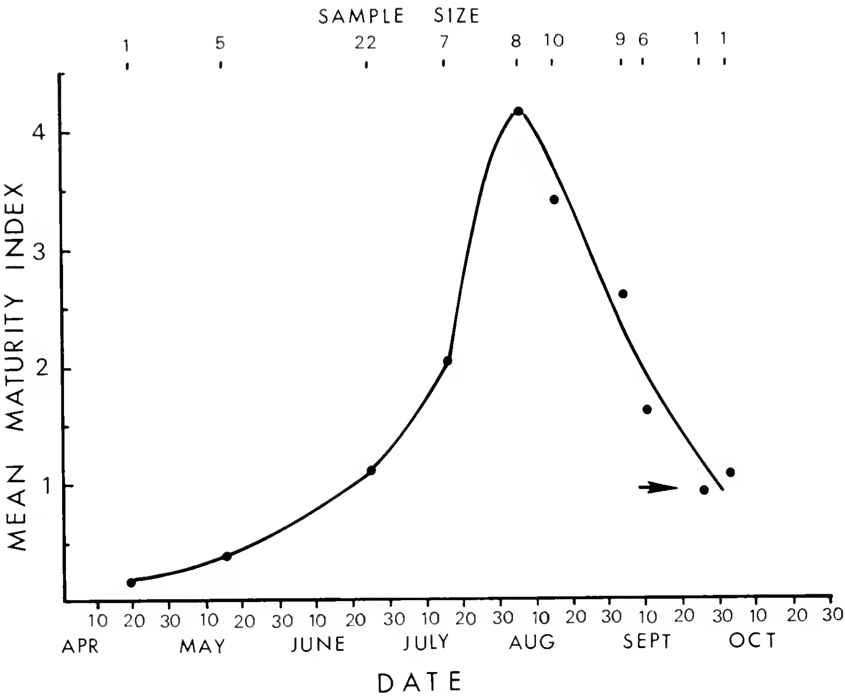

FIGURE 5. The annual reproductive cycle of male silver surfperch from the Oregon coast during 1968. (Maturity index = gonad weight × 100 divided by body weight. The line was fitted by eye. The arrow indicates when milt was readily emitted.)

Mating by silver surfperch occurred in fall (late September) and birth of the young occurred from late June to early August of the following year, approximately 9 months later. Few fish were captured from October to January, so the development of the embryos could not be followed during that period. The embryos grew from about 6 mm SL in January to 40 mm SL or more by June or July (Table 3).

Fecundity

Information on the fecundity of silver surfperch has been summarized (Table 3). Although the embryos were near term and some may have been lost during the capture of the fish, our experience with surfperch revealed that the female did not void embryos readily unless stressed by either low dissolved oxygen, increased temperatures, or both. Probably less stress would cause the embryos to be voided by the female as she became closer to term. During this study we kept each female in a separate plastic bag when the fish could not be transferred

TABLE 3. **The Size and Age of Female Surfperch and the Number and Size of Their Embryos by Date of Collection.**

Date	Female*			Embryos†		
	Total length (mm)	Weight (g)	Age	Number	Mean standard length (mm)	Standard deviation
June 27, 1967	174	77	II+	4	31.3	----
June 27, 1967	198	116	III+	5	39.8	0.84
June 27, 1967	203	134	III+	5	37.2	0.84
June 27, 1967	215	165	III+	14	36.2	0.67
June 28, 1967	175	95	II+	10	32.8	0.63
June 28, 1967	189	120	III+	7	36.1	0.63
June 28, 1967	203	138	III+	12	36.6	0.38
May 5, 1968	190	102	III+	9	18.3	0.26
June 21, 1968	219	172	III+	16	36.2	0.81
June 25, 1968	218	182	III+	11	44.7	0.61
June 25, 1968	221	184	III+	17	41.7	0.71
Jan. 2, 1969	210	136	III+	9	6.8	0.09

* Length and weight taken from fresh specimens.
† Lengths taken from embryos preserved in 10% buffered formalin. Mean shrinkage of fresh embryos from three females was 7.83% after 20 months in preservative.

alive to the laboratory and, therefore, minimized the possibility of embryo loss. Regression equations that describe the relationship of female size and fecundity for silver surfperch were calculated from the data (Table 3). These equations are:

$$E = 0.178\text{TL} - 25.926;\ r = 0.68;\ n = 12$$
$$E = 0.093\text{WT} - 2.687;\ r = 0.76;\ n = 12$$

where E = number of embryos, TL = total length in mm, WT = weight in grams, r = correlation coefficient, and n = sample size.

A few females collected in late June were recently spent and all females were spent after August.

On August 14, 1968, we captured 74 silver and one walleye young-of-the-year surfperches from a tidepool. The lengths of the smallest silver surfperch (Figure 6) were similar in size to the largest embryos found in females (Table 3). These data suggest that silver surfperch are approximately 40–45 mm SL at birth and that the spawning season extends from late June into early August. The length-frequency plots also indicate that newly born young may quickly join schools of other young-of-the-year silver surfperch (Figure 6).

Unique Parasite on Embiotocid Gills

The surf-dwelling members of the Embiotocidae (redtail, walleye, and silver surfperches) are parasitized by a unique unnamed monogenetic trematode. Dr. Ivan Pratt, Professor of Zoology at Oregon State University, is now describing and naming this new species that he states is in the genus *Diclidophora* (pers. comm.). Because this parasite is a new species, records were maintained of the numbers of adult trematodes that were found on the gills of the silver surfperch. Because age and growth are related (Figure 3), one might speculate that larger fish may have a greater likelihood of becoming parasitized. Therefore, analyses were made by age and by size of fish. In general,

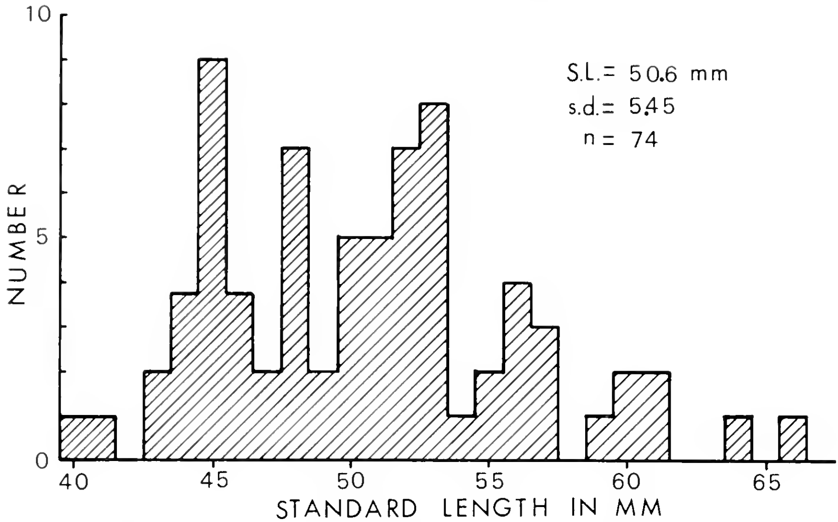

FIGURE 6. Length frequency of young-of-the-year silver surfperch that were captured in a tidepool at Seal Rocks, Oregon on August 14, 1968.

the fish had a greater number of parasites as they become older (Table 4) and as they became larger (Table 5). Also, in general, a greater percentage of the fish were infected as they became older (Table 4) and larger (Table 5). A similar trend for this parasite was found in the redtail surfperch (Bennett and Wydoski Ms.).

TABLE 4. The Relationship of Age in Silver Surfperch to Infestation by the Monogenetic Trematode, *Diclidophora sp.*

Age group	Number of fish examined	Percentage of fish infected	Mean number of trematodes per infected fish
I	7	14.3	1.00
II	21	42.9	1.44
III	19	42.1	2.00
IV	16	56.3	1.67
V	20	50.0	2.10
VI	10	20.0	1.50
VII	4	0	----

Sportfishery

The maximum size of the silver surfperch has been reported to be a length of 10.5 inches (267 mm) (Miller, Gotshall, and Nitsos 1965). The largest size for this species that was recorded during an intensive study by the California Department of Fish and Game from the Oregon border to Point Arguello was 8.5 inches (216 mm) (Miller and Gotshall 1965). Miller and Gotshall stated that silver surfperch ranked third by number in the ocean sport catch of shore fisherman from Oregon to Point Arguello. In this fishery, the barred surfperch ranked first by number and the redtail surfperch ranked second.

TABLE 5. The Relationship of Size in Silver Surfperch to Infestation by the Monogenetic Trematode, *Diclidophora* sp.

Total length (mm)	Number of fish examined	Percentage of fish infected	Mean number of trematodes per infected fish
121–130	1	0	----
131–140	1	0	----
141–150	5	20.0	1.00
151–160	1	0	----
161–170	6	66.7	1.75
171–180	10	30.0	1.00
181–190	11	45.5	2.40
191–200	6	50.0	2.67
201–210	25	48.0	1.58
211–220	21	42.9	2.22
221–230	8	25.0	1.00
231–240	--	----	----
241–250	1	0	----

A 10-inch silver surfperch would be about ½ lb. (Figure 4). Although the silver surfperch is small when compared with the redtail surfperch that also inhabits the surf zone from northern California to British Columbia, it is, nevertheless, quite abundant at times and can supply a good deal of recreation. Miller and Gotshall (1965) state that the redtail and silver surfperches are the most common surf species in northern California and that both species are taken consistently on all beaches north of San Francisco. In Humboldt Bay the silver surfperch was taken in about half of the sampling periods near the warmwater discharge from an atomic steam-generating plant (Allen, Boydstun, and Garcia 1970). Between April 1967 and April 1969 we found that the silver surfperch occurred sporadically along the Oregon Coast. Generally, this species and the redtail surfperch appeared to travel in rather tight schools and move continually. This statement is based upon the flurries of activity that we observed in the sport fishery and while sampling with gill nets and hook-and-line. The silver surfperch does not feed as vigorously as the redtail surfperch. Hence, an angler possibly may not catch as many silvers as redtails because he is anticipating a solid strike of the redtail instead of the dainty "tapping" strike of the silver surfperch. This behavioral trait and the smaller mouth in the silver surfperch may account for fewer numbers in the surf angler's catch. Most anglers we observed used too large a hook to consistently catch the silver surfperch. If hooks larger than size 6 are used, then few silver surfperch will be taken. On several occasions more silver surfperch were present than the redtail and the correct angling technique could take these fish.

ACKNOWLEDGMENTS

We wish to express our appreciation to Richard R. Whitney of the Washington Cooperative Fishery Unit and Paul G. Wares of the Tiburon Marine Laboratory for reviewing the manuscript.

REFERENCES

Allen, G. H., L. B. Boydstun, and F. G. Garcia. 1970. Reaction of marine fishes around warmwater discharge from an atomic steam-generating plant. Progressive Fish-Cult. 32(1) : 9–16.

Anderson, R. D., and C. F. Bryan. 1970. Age and growth of three surfperches (Embiotocidae) from Humboldt Bay, California. Trans. Amer. Fish. Soc. 99(3) : 475–482.

Carlisle, J. G., Jr., J. W. Schott and N. J. Abramson. 1960. The barred surfperch (*Amphistichus argenteus*) in southern California. Calif. Dep. Fish and Game, Fish Bull. 109 : 1–79.

Gnose, C. 1968. Ecology of the striped seaperch (*Embiotica lateralis*) in Yaquina Bay, Oregon. M.S. Thesis, Oregon State University, Corvallis. 53 p.

Gordon, C. D. 1965. Aspects of the age and growth of *Cymatogaster aggregata* Gibbons. M.S. Thesis, Univ. British Columbia, Vancouver. 90 p.

Lagler, K. F. 1956. Freshwater fishery biology. 2nd ed. Wm. C. Brown Co., Dubuque, Iowa, 421 p.

Miller, D. J. and D. W. Gotshall. 1965. Ocean sportfish catch and effort from Oregon to Point Arguello, California. Calif. Dep. Fish and Game, Fish Bull. 130 : 1–135.

Miller, D. J., D. Gotshall, and R. Nitsos. 1965. A field guide to some common sport fishes of California. (2nd revision) Calif. Fish and Game, Sacramento, 87 p.

Peden, A. E. 19–6. Rare marine fishes from British Columbia with first records of silver perch, *Hyperprosopon ellipticum*, and shanny, *Letoclinus maculatus*. J. Fish. Res. Bd. Canada 23(8) : 1277–1280.

Schaefer, R. H. 1967. Species composition, size and seasonal abundance of fish in the surf waters of Long Island. New York Fish and Game J. 14(1) : 1–46.

Sivalingom, S. 1953. Age and growth of *Taeniotoca lateralis*. M.S. Thesis, Univ. Washington, Seattle. 53 p.

Stroud, R. H. 1971. Marine sport fisheries research. Sport Fish. Institute, Bull. (221) : 1–3.

Tarp, F. H. 1952. A revision of the family Embiotocidae (the surfperches). Calif. Dep. Fish and Game, Fish Bull. 88 : 1–99.

U.S. Bureau Sport Fisheries and Wildlife. 1959. A prospectus for marine game fish research. U.S. Dep. Interior, Bureau of Sport Fish. and Wildlife, Washington, D.C. 12 p.

Wares, P. G. 1968. Biology of the pile perch (*Rhacochilus vacca*). M.S. Thesis, Oregon State Univ., Corvallis. 73 p.

Calif. Fish and Game 59(3): 191–195. 1973.

INCONSISTENCIES IN LOCATING THE FIRST ANNULUS OF PACIFIC SARDINES[1]

MAKOTO KIMURA

National Marine Fisheries Service
La Jolla, California 92037

A special scale reading session designed to bring together old and new scale readers to compare the criteria for estimating the first annulus in sardine scales (L_1), examined scales collected from the 1941 through 1962 sardine landings. Estimates of L_1 by the original readers were consistently lower than those of the newer readers. The reported increase in Pacific sardine length at the formation of first annulus appears to be due to a change in the older reader's criteria for the position of the first annulus. In addition, there was a gradual replacement of the older readers by newer ones who consistently read higher and thus overestimated L_1. Hence, it appears that there was no real change in sardine growth rates during these years.

INTRODUCTION

Walford and Mosher (1943a, 1943b) validated the use of scales for estimating the age of the Pacific sardine and set criteria for the scale annulus. In 1960, I suspected the sardine scale readers were not strictly following the criteria in locating the first or innermost annulus. The radius of this annulus is used to estimate the L_1 (defined as (i)) the calculated length of the fish at the end of the first year of life (Marr 1960), or (ii) the calculated length of the fish at the time of formation of the ring in the first year of life (Phillips 1948a). From information obtained on the time of annulus formation on known-age sardine (Kimura and Sakagawa 1972) the second definition is recommended.

The L_1 is one of the basic measurements for estimating growth (Phillips 1948b). It has also been used as a parameter to separate subpopulations (Felin 1954), and to support certain hypothesis about the population (Marr 1960). The importance of the parameter warranted that a study be made to determine if scale readers were changing L_1 estimates by mislocation of the first annulus.

Preliminary analysis of the scale-age data and rereads of a random number of scales for the 1941–42 through 1961–62 seasons indicated that the only conclusive way to settle the matter was by direct comparison of scale reading between the original scale readers and the readers then in tenure. This report describes the results of the comparative scale reading.

MATERIALS AND METHODS

On March 25–29, 1963, the three original scale readers and the circa 1963 scale readers met at Hopkins Marine Station, Monterey, California, to determine whether the latter readers were following the original

[1] Accepted for publication March 1973.

readers' criteria in reading Pacific sardine scales. Since the three original readers had been away from such work for so long, certain steps were taken to ensure their ability to read scales in the same way as they did during their tenure. For practice they were sent, 4 months before the formal meeting, 100 scale slides which each had read and recorded during his tenure. They also practiced as a group prior to the formal meeting, and a test was carried out for consistency in aging with 60 slides selected from the 1941–42 through 1943–44 season. They agreed about 88% of the time, which compared favorably to the 80–90% agreement when they were in tenure. The 1963 readers did not practice but were told to read in the same manner as they were doing.

At the formal meeting each reader read independently the same preselected scales from 105 scale samples of fish taken in the San Pedro, California, fishery. The pre-selected scales were those selected originally by the historical scale readers (as recorded on scale cards) and were distinguished from the others for the present test by encircling with a glass-marking pen. The remaining scales on the slide were left in view to aid each reader in his evaluation of the annulus.

Other test scale readings included individual readings on the same slides but each individual selecting a scale of his choosing, two-separate group readings on the same slides, and a final reading whereby all seven readers together read a series of slides. All showed the same trend as is described for the test in the present report.

After viewing the scale on a scale projector, the reader recorded the radii of all annuli, and also the margin of the scale on a scale card. The reader went through the same procedure for each of the 105 slides; five slides for each of the 21 seasons from 1941–42 through 1961–62, the same method used and described by Felin and Phillips (1948). The back-calculated lengths of the fish at various annuli were obtained with a nomograph by the method of Phillips (1948a).

The average L_1 values were calculated for the original and the 1963 readers, respectively, and the results compared. The average L_1's from the historical data used to prepare the age and length reports for the Pacific sardine reported by Wolf (1961) were also calculated for comparison.

RESULTS

A graphic comparison of L_1 estimations by seasons for both groups of readers and the historical readers shows that the L_1 estimates of the original readers were consistently lower than those of the 1963 readers (Figure 1). The historical average L_1 had a positive trend with time but the other two did not.

DISCUSSION

A comparison of the scale readings shows that the 1963 scale readers were not following the criteria of the original readers. Therefore, the average L_1 values which were used as a basic measurement for estimating growth, to separate subpopulations, and to support certain hypothesis about the population needed to be reexamined. For example, Marr (1960) found a positive trend with time in the L_1 values for the year-classes 1934 through 1955 for the fishery at San Pedro. He assumed that the increase in length of L_1 was caused by biological or

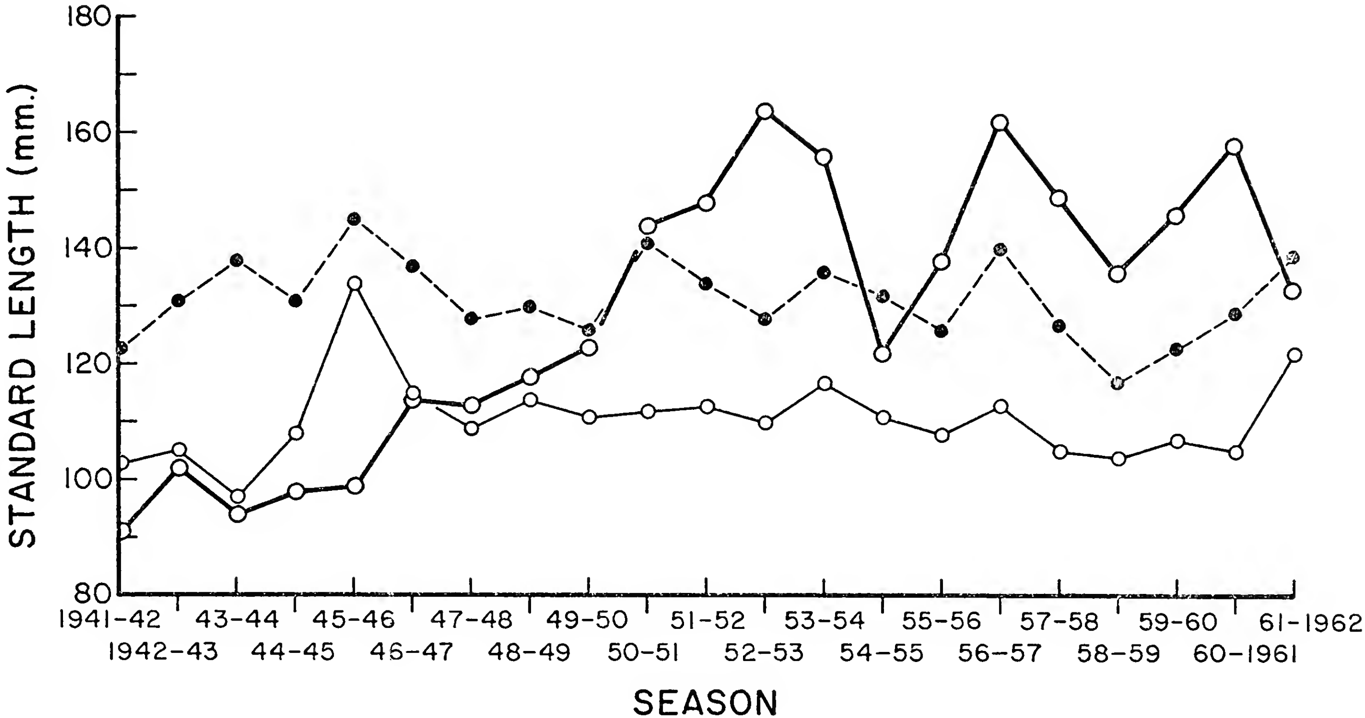

FIGURE 1. Comparison of calculated sardine lengths in mm at first scale annulus (L_1)-in time. The heavy line connects averages of L_1's from scales of five fish in each season as they were historically read. The light line connects the averages of L_1's of the three original scale readers and the dashed line connects the L_1's of the four 1963 readers.

environmental factors which affected the Pacific sardine; but, this study indicates the change in L_1 was the result of scale reader bias.

The consensus of opinions among scale workers is that consistency among a group of readers, or the presence of experienced readers guarantee results comparable to past results. However, there were two experienced readers present at the time the historical L_1 estimation began its abrupt increase in the mid-1940's. The present study indicates that while the 1963 readers were consistent among themselves, their criteria were inconsistent with those of the original readers. Kimura and Sakagawa (1972) concluded on the basis of a comparison of L_1 of known age sardine with the average L_1 of fish aged by the early and recent scale readers that the early readers' L_1 estimations were closer to that obtained from the known age fish.

The results obtained here indicate a need for some kind of standard or length-by-age values to serve as a reference to the readers in obtaining back-calculated length measurements. A suggested standard is a series of random, stratified-by-age scales, i.e., O-, I-, II-, III-, . . . n-year-old fish scales, preferably selected from the time period when the validators of the scale (otolith and any other bony structures used in aging) method were in tenure, or were used by the validators as the basis of their study. For the sake of simplifying comparative readings and as assurance that the same scale will be read at all times, the initial readers of the standard series of slides should circle the selected scale with a marking pen. Similarly, the slides read routinely during a season should also be circled by the initial reader so that both a reader and the checker can be certain to have examined the same scales.

The presence of such a set of standard slides probably would (i) assure continuity in the manner of the scale interpretation by the original validators of the scale or any other method used in estimating fish age, (ii) counteract and monitor the effect of dominance of any individual scale reader, and (iii) deter the occurrence of similarly costly mistakes as illustrated in this study.

CONCLUSIONS

The circa 1963 scale readers have not been reading like the original readers and, apparently, have not been following the same criteria in estimating the L_1. The L_1 value change in time resulted from scale-reader subjectivity and was not caused by biological or environmental factors.

ACKNOWLEDGMENTS

My thanks to the original scale readers, Dr. L. A. Walford, Mr. K. H. Mosher, and Mr. J. B. Phillips, and to the 1963 scale readers, Miss A. E. Daugherty, Mr. H. Hyatt, and Mr. R. S. Wolf, for participating in the scale-reading workshop. The editorial assistance of staff members of the National Marine Fisheries Services, and to a number of other staff members of the same organization who gave their time as "sounding boards" are acknowledged.

REFERENCES

Felin, Frances E. 1954. Population heterogeneity in the Pacific pilchard. U.S. Fish Wildl. Serv., Fish. Bull. 86(54) : 201–225.

Felin, Frances E. and Julius 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. (69) : 122 p.

Kimura, Makoto and Gary T. Sakagawa. 1972. Observations on scale patterns and growth of the Pacific sardine reared in the laboratory. Fish. Bull., U.S. 70(3) : 1,043–1,052.

Marr, John C. 1960. The causes of major variations in the catch of the Pacific sardine, *Sardinops caerulea* (Girard). Proceedings FAO World Sci. Meet. Biology of Sardines and Related Species, Rome, 14–21 September 1959; 667–791.

Phillips, Julius B. 1948a. Comparison of calculated fish lengths based on scales from different body areas of the sardine, *Sardinops caerulea*. Copeia, 1948, 2 : 99–106.

———. 1948b. Growth of the sardine, *Sardinops caerulea*, 1941–42 through 1946–47. Calif. Div. Fish and Game, Fish Bull. (71) : 33 p.

Walford, Lionel A. and Kenneth M. Mosher. 1943a. Studies on the Pacific pilchard or sardine (*Sardinops caerulea*). 2. Determination of the age of juveniles by scales and otoliths. U.S. Fish Wildl. Serv. Spec. Sci. Rep. 21, 29 p. (Reissued in Spec. Sci. Rep. Fish. 15 : 31–95, 1950.)

———. 1943b. Studies on the Pacific pilchard or sardine (*Sardinops caerulea*). 3. Determination of age of adults by scales and effect of environment on first year's growth as it bears on age determination. U.S. Fish Wildl. Serv. Spec. Sci. Rep. 21, 29 p. (Reissued in Spec. Sci. Rep. Fish. 15 : 96–131, 1950.)

Wolf, Robert S. 1961. Age composition of the Pacific sardine 1932–1960. U.S. Fish Wildl. Serv. Res. Rep. 53, 36 p.

Calif. Fish and Game 59(3):196–206. 1973.

FISH PARASITES OCCURRING IN THIRTEEN SOUTHERN CALIFORNIA RESERVOIRS[1]

RICHARD L. MILLER[2] and ANDREW C. OLSON, JR.
California State University, San Diego

and

LEE W. MILLER
Bay-Delta Fisheries Project
California Department of Fish and Game

Four hundred eighty fishes representing 13 freshwater species from 7 genera and 4 families were collected from 13 reservoirs and examined for metazoan parasites. *Dorosoma petenense, Cyprinus carpio, Notemigonus crysoleucas, Ictalurus catus, I. melas, I. natalis, I. nebulosus, I. punctatus, Lepomis cyanellus, L. macrochirus, Micropterus salmoides, Pomoxis annularis,* and *P. nigromaculatus* were infected with one or more helminths. Parasites found were Digenea: *Hysteromorpha triloba, Posthodiplostomum minimum, Uvulifer ambloplitis,* and *Clinostomum marginatum;* Monogenea: *Dactylogyrus extensus, Cleidodiscus pricei, Urocleidus dispar, U. ferox, U. furcatus, U. principalis,* and *Actinocleidus fusiformis;* Cestoda: *Corallobothrium fimbriatum, C. giganteum, Proteocephalus ambloplitis, Proteocephalus* sp., and *Bothriocephalus claviceps;* Nematoda: *Contracaecum* sp. and *Eustrongylides* sp.; Acanthocephala: *Southwellina hispida;* and Hirudinea: *Myzobdella moorei.* Of these twenty parasites, four are new records for California. This survey will provide some baseline data for fisheries management in San Diego County and southern California.

INTRODUCTION

Only two extensive freshwater fish parasite surveys have been conducted in California. Haderlie (1953) sampled 2,010 fishes representing 36 species in northern California. Edwards and Nahhas (1968) examined 236 fishes representing 26 species in the Sacramento-San Joaquin Delta. Studies of monogenetic trematodes from freshwater fishes, primarily in central California, have been made by Mizelle 1962; Mizelle and Crane 1964; Mizelle and Price 1964; Price and Mizelle 1964; Mizelle and Kritsky 1967a, 1967b; Crane and Mizelle 1968; Kritsky and Mizelle 1968; and Mizelle and McDougal 1970. In southern California, studies have dealt primarily with the incidence of *Posthodiplostomum minimum* metacercariae (Colley and Olson 1963; R. L. Miller 1967).

Our study was initiated to determine the incidence and intensity of parasitic metazoans in fishes from reservoirs in San Diego County, California, and relate this to fisheries management policies concerning stocking and movement of fish. These reservoirs are primarily used for water storage, although fishing is an important use. The reservoirs were selected for study based on their geographical distribution (Figure 1),

[1] Accepted for publication January, 1973. This study was partly financed by Fish and Game fine money provided by the San Diego County Fish and Game Commission.

[2] Present address: Dep. of Zoology, Oregon State University, Corvallis, Oregon 97331.

water source, and convenience of sampling. Barrett, Lake Henshaw, Loveland, Sutherland and Upper Otay reservoirs are completely dependent upon winter runoff, whereas El Capitan, Hodges, Lower Otay, Miramar, San Vicente, Sweetwater, Wohlford, and Mathews all have aqueduct connections for receiving imported Colorado River water.

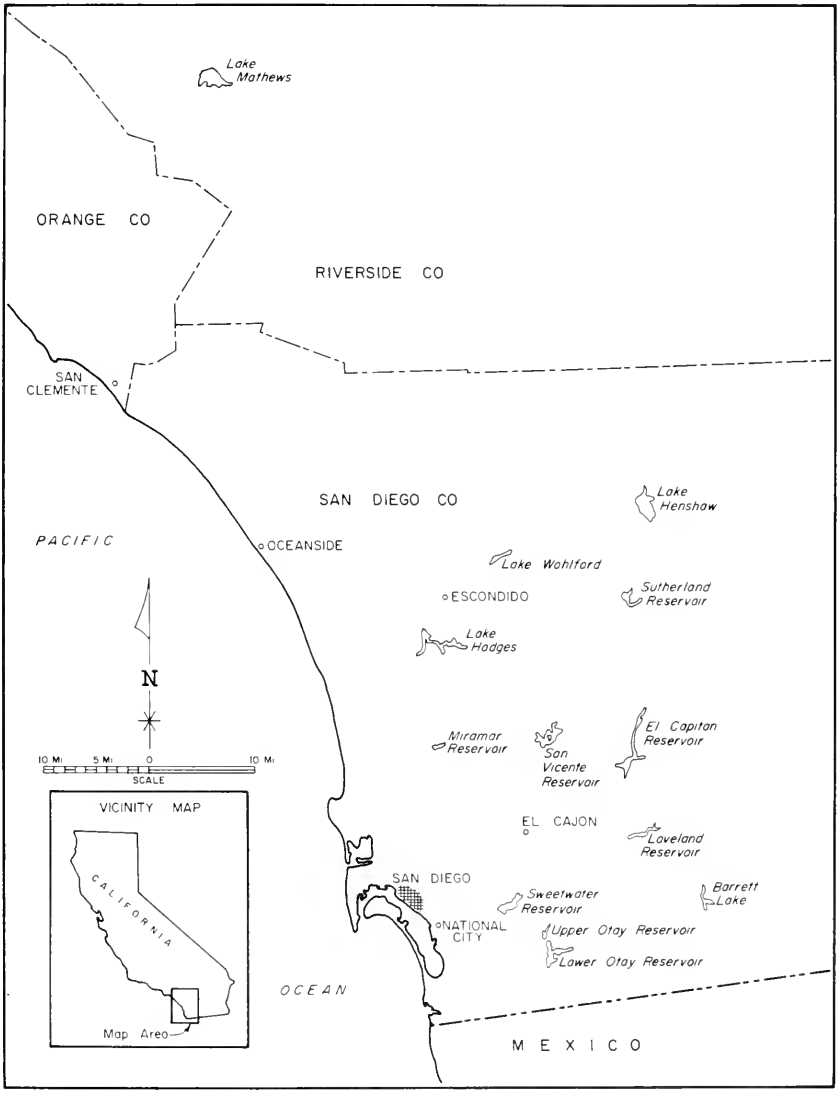

FIGURE 1. Map of the study area showing the reservoirs sampled for fish parasites.

Lake Mathews in Riverside County is the distribution point for Colorado River water coming to San Diego County, hence our survey of that water to determine its parasite fauna in relation to the San Diego reservoirs.

SAMPLING AND EXAMINATION OF FISH

Collections of 480 fishes were made from April to September 1966 in 13 southern California reservoirs (Figure 1). Two collections involving parasites not found during the survey are included in the list of parasites and hosts. The fish represented 13 species from 7 genera and 4 families. Fish were collected by seines, gill nets, electrofishing, angling, and 5% emulsified rotenone. Our goal was to sample 10 fish of each species present in each reservoir. However, sampling difficulties precluded attaining that goal.

All fish were examined within 3 days of collection. They were kept alive or placed on ice until necropsy; standard procedures were used to examine for external and internal parasites. The heart, pericardium, liver, spleen, kidneys, and gonads were removed and each was squeezed between gridded glass plates in order to make counts of the parasites present. The gills were removed and in some cases examined immediately for monogenetic trematodes, while in other cases they were frozen before examination. Counts of the monogenes are not quantitative because of the difficulty of thoroughly examining all the gill material, and because their microscopic size made them difficult to recover. As a result, incomplete collections were made and all monogenes from a fish species were preserved together rather than from individual fish.

Trematodes, cestodes, and acanthocephalans were relaxed in tapwater, then fixed in AFA (alcohol-formalin-acetic acid) or 5% formalin. Leeches were relaxed in tap water with menthol crystals added, then fixed in AFA or 5% formalin. Nematodes were killed in hot alcohol and stored in an alcohol-glycerine mixture. Trematodes and cestodes were stained in Mayer's carmalum or Harris' haematoxylin and mounted in Permount, or mounted directly in Turtox CMC-10 or CMCS.

CHECK LISTS OF PARASITES AND FISHES

The results are arranged in two check lists. The first is a list of each parasite found in the survey, followed by a list of hosts. The fraction after the host species indicates the number of fish infected and the number of fish examined (incidence). The reservoirs from which the hosts were collected are listed, followed by the incidence of infection, the mean number of parasites per infected host (X), and the range in intensity of infection (R), if applicable, plus the locations from which the parasites were recovered. Two tables presenting the data on bluegill and largemouth bass are included within this list.

The second check list presents the parasites under the host species. The fish are arranged in phylogenetic order following Bailey (1970) and the parasites are listed in their taxonomic categories following each fish species. The numbers in parentheses following the host species indicate the incidence of infection, while the number after each parasite indicates the number of fish in which the parasite was found.

Except for *Cleidodiscus pricei*, no quantitative data are presented for Monogenea; i.e. incidence, mean number of parasites, or range of intensity of infection. In both lists larval forms are indicated by an asterisk (*) and new California records are indicated by the symbol (†).

List 1. PARASITES WITH HOSTS

DIGENEA

**Hysteromorpha triloba* (Rud. 1819) Lutz 1931

Host: *Ictalurus nebulosus* (LeSueur) (3/3) : Lower Otay (3/3).

Site: Muscles.

These metacercariae were not recovered in the 1966 collections but Olson collected them on December 3, 1957, from Lower Otay. The infections were very conspicuous, making the muscles appear granular and caused fishermen to stop fishing for bullheads at that time.

**Posthodiplostomum minimum* (McCallum 1921) Dubois 1936

Hosts: *Lepomis cyanellus* Rafinesque (8/12) : Barrett (2/2) 35 (1–70) ; San Vicente (5/5) 20 (3–41) ; Sutherland (0/1) ; Sweetwater (0/1) ; Wohlford (0/1) ; Mathews (1/2).

Lepomis macrochirus Rafinesque (111/125) :—see Table 1.

Micropterus salmoides (Lacépède) (180/185) :—see Table 2.

Pomoxis annularis Rafinesque (16/42) : Barrett (0/11) ; Hodges (3/15) 2 (1–3) ; Lower Otay (10/10) 122 (48–233) ; Sweetwater (3/6) 9 (1–24).

Site: Liver, heart, spleen, kidneys, mesentery.

The metacercarie of *P. minimum* were the most abundant of the parasites encountered in the survey, infecting 97.3% of the bass, 88.8% of the bluegill, and 38.1% of the white crappie. All reservoirs in the survey had fish infected with *P. minimum*. Intensity of infections was highly variable between different species within the same water and between different waters with the same host. For example, in Lake Henshaw the mean number of metacercariae per largemouth bass was 814, with a range of 78 to 2,245, whereas 11 black crappie examined were completely free of *P. minimum*. In Barrett Reservoir 10 bass averaged 1,931 metacercariae each, with a range of 61 to 5,730, whereas 12 bass examined from San Vicente averaged only 23 per host, with a range of 5 to 154. Similar variations were observed with bluegill (Table 1).

†**Uvulifer ambloplitis* (Hughes 1927) Dubois 1938

Host: *Lepomis cyanellus* Rafinesque (5/6) : Los Penasquitos Creek (5/6) : 40 (7–102).

Site: Skin and muscles.

These metacercariae were recovered from Los Penasquitos Creek, San Diego County, on March 16, 1969. The belted kingfisher, *Megaceryle alcyon* (Linnaeus), is the definitive host of this parasite (Olsen 1962). This sample, while not taken from a reservoir, is included here as a new record for California.

**Clinostomum marginatum* (Rud. 1819) Leidy 1856

Hosts: *Dorosoma petenense* (Gunther) (15/26) : El Capitan (9/10) 15 (8–26) ; Hodges (0/10) ; Lower Otay (6/6) 2 (1–3).

Ictalurus catus (Linnaeus) (1/8) : Lower Otay (1/5) 1; Sweetwater (0/3).

Ictalurus melas (Rafinesque) (5/10) : Lower Otay (5/10) 3 (1–7).

Lepomis cyanellus Rafinesque (1/12) : Barrett (1/2) 2; Mathews (0/2) ; San Vicente (0/5) ; Sutherland (0/1) ; Sweetwater (0/1) ; Wohlford (0/1).

Lepomis macrochirus Rafinesque (30/125) :—see Table 1.

Micropterus salmoides (Lacépède) (56/185) :—see Table 2.

Site: Skin, muscles, coelom, mesentery, orbit of eye.

This species was found in all of the reservoirs except Miramar and Sweetwater. The first occurrence in *Dorosoma petenense* was previously reported by L. W. Miller (1967).

MONOGENEA

The following monogenes were all found on the gills:

Dactylogyrus extensus Mueller and Van Cleave 1932

Host: *Cyprinus carpio* Linnaeus (5/9): Hodges (0/1); Mathews (5/5); Sweetwater (0/3).

Cleidodiscus pricei Mueller 1936

Hosts: *Ictalurus catus* Linnaeus (5/8): Lower Otay (5/5); Sweetwater (0/3).
Ictalurus melas (Rafinesque) (5/10): Lower Otay (5/10).
Ictalurus natalis (LeSueur) (4/4): El Capitan (3/3); Wohlford (1/1).
Ictalurus nebulosus (LeSueur) (2/5): Barrett (0/2); El Capitan (1/2); Henshaw (1/1).
Ictalurus punctatus (Rafinesque) (11/31): El Capitan (11/11); Hodges (0/10); Mathews (0/5); Sweetwater (0/5).

Urocleidus dispar (Mueller 1936) Mizelle and Hughes 1938

Hosts: *Lepomis macrochirus* Rafinesque: Sutherland.
Micropterus salmoides Lacépède: San Vicente.

Urocleidus ferox Mueller 1934

Host: *Lepomis macrochirus* Rafinesque: Sutherland.

Urocleidus furcatus (Mueller 1937) Mizelle and Hughes 1938

Hosts: *Lepomis cyanellus* Rafinesque: San Vicente.
Lepomis macrochirus Rafinesque: Sutherland.
Micropterus salmoides Lacépède: El Capitan.

Urocleidus principalis (Mizelle 1946) Mizelle and Hughes 1938

Host: *Micropterus salmoides* Lacépède: El Capitan; Henshaw; San Vicente.

Actinocleidus fusiformis (Mueller 1934) Mueller 1937

Host: *Micropterus salmoides* Lacépède: El Capitan.

CESTODA

Corallobothrium giganteum Essex 1927

Host: *Ictalurus punctatus* (Rafinesque) (26/31): El Capitan (11/11); Hodges (10/10); Mathews (5/5); Sweetwater (0/5).

Site: Intestine.

Specimens measured from 4 mm to at least 39 mm in length and represented developmental stages from immature to gravid. During the examination these small worms were assumed to be growing forms of *C. giganteum*, with which they were associated. As a result, counts of each species were not made and many of the worms were not saved. It was noted that *C. fimbriatum* dominated the counts. The combined count of *C. fimbriatum* and *C. giganteum* in the El Capitan collection showed a range of 4 to 21 and a mean of 11 worms per fish while the Mathews range was 4 to 38 with a mean of 18.

Corallobothrium giganteum Essex 1927

Host: *Ictalurus punctatus* (Rafinesque) (16/31): El Capitan (11/11); Hodges (0/10); Mathews (5/5); Sweetwater (0/5).

Site: Intestine.

The longest worm was 205 mm; all worms had gravid proglottids.

Proteocephalus ambloplitis (Leidy 1887)

Hosts: *Micropterus salmoides* (Lacépède) (14/185): see Table 2.
Site: Intestine.

**Proteocephalus* sp.

Hosts: *Lepomis cyanellus* Rafinesque (6/12): Barrett (0/2); San Vicente (3/5) 20; Wohlford (1/1) 7; Mathews (2/2) 32 (14–50); Sweetwater (0/1); Sutherland (0/1).
Lepomis macrochirus Rafinesque (11/125): see Table 1.

Micropterus salmoides (Lacépède) (68/185) : see Table 2.
Pomoxis annularis Rafinesque (1/42) : Barrett (0/11) ; Hodges (1/15) 10; Lower Otay (0/10) ; Sweetwater (0/6).

Site: Liver, spleen, kindeys, gonads, mesentery, coelom.

†*Bothriocephalus claviceps* (Goeze 1782) Rud. 1810

Hosts: *Lepomis cyanellus* Rafinesque (2/12): Barrett (1/2) 2; San Vicente (1/5) 1; Sweetwater (0/1); Sutherland (0/1) ; Wohlford (0/1) ; Mathews (0/2).
Lepomis macrochirus Rafinesque (16/125) : see Table 1.

Site: Pyloric caeca and intestine.

Our specimens most closely resemble the description given by Cooper (1918) and comparison specimens of *B. claviceps* loaned by J. T. Self. The other record of this genus in California is by Edwards and Nahhas (1968), who reported four immature *Bothriocephalus* sp. in *Lepomis cyanellus.*

NEMATODA

**Contracaecum* sp.

Hosts: *Lepomis macrochirus* Rafinesque (6/125) : see Table 1.
Micropterus salmoides (Lacépède) (32/185) : see Table 2.
Pomoxis annularis Rafinesque (1/42) : Barrett (0/11) ; Hodges (0/15) ; Lower Otay (1/10) 1; Sweetwater (0/6).
Pomoxis nigromaculatus (LeSueur) (8/14) : El Capitan (0/1) ; Henshaw (8/11) 4; Sweetwater (0/2).

Site: Encysted in the mesenteries and pericardial cavity.

Our specimens match the illustrations of Haderlie (1953), who identified them as *Contracaecum spiculigerum* (Rud. 1809). We have not placed these larval forms to species even though cormorants, the definitive hosts of *C. spiculigerum*, are often observed at the reservoirs.

Eustrongylides sp.

Host: *Lepomis macrochirus* Rafinesque (1/125) : see Table 1.

Site: Muscles.

ACANTHOCEPHALA

†**Southwellina hispida* (Van Cleave 1925) Witenburg 1932

Host: *Micropterus salmoides* (Lacépède) (5/185) : see Table 2

Site: Mesentery near intestine.

According to Gerald D. Schmidt (pers. comm.) *Arhythmorhynchus duocintus* is a junior synonym of *S. hispida*. This is the first California record of this worm and apparently the first record of this juvenile in a freshwater fish in North America. Adults were collected from a black-crowned night heron, *Nycticorax nycticorax*, in the New York Zoological Park (Lincicome 1943).

HIRUDINEA

†*Myzobdella moorei* (Meyer 1940) Meyer 1946 (*Illinobdella m.*)

Hosts: *Ictalurus punctatus* (Rafinesque) (12/31) : El Capitan (0/11) ; Hodges (10/10) 3; Mathews (2/5) 2; Sweetwater (0/5).

Lepomis cyanellus Rafinesque (2/12): Barrett (0/2); San Vicente (2/5) 3; Sutherland (0/1); Sweetwater (0/1); Wohlford (0/1); Mathews (0/2).

Lepomis macrochirus Rafinesque (21/125) : see Table 1.

Micropterus salmoides Lacépède (25/185) : see Table 2.

Notemigonis crysoleucas (Mitchill) (4/9) : Lower Otay (4/5) 2; Sutherland (0/4).

Pomoxis annularis Rafinesque (4/42) : Barrett (0/11) ; Hodges (0/15) ; Lower Otay (0/10) ; Sweetwater (4/6).

Pomoxis nigromaculatus (LeSueur) (6/14): Barrett (0/1) ; Henshaw (5/11) 3; Sweetwater (1/2) 8.

Site: Skin and mouth. This species is an ectoparasite which could easily be detached by our handling and transporting; hence, these are minimum estimates of intensity and incidence.

TABLE 1. **Parasites Occurring in Bluegill, *Lepomis macrochirus*, in 13 Southern California Reservoirs.**

Reservoir	Number examined	*Posthodiplostomum minimum*			*Clinostomum marginatum*			*Bothriocephalus claviceps*			*Protocephalus* sp.			*Contracaecum* sp.			*Eustrongyloides* sp.		*Myzobdella moorei*		
		N*	$\bar{X}$	R	N	$\bar{X}$	R	N	$\bar{X}$	R	N	$\bar{X}$	R	N	$\bar{X}$	R	N	$\bar{X}$	N	$\bar{X}$	R
Barrett	10	10	803	(120–2,524)	3	5	(1–7)	2	1												
El Capitan	21	21	152	(11–731)				4	1.5	(1–2)				1	1						
Henshaw	11	11	975	(605–2,099)	5	2	(1–3)	6	3	(1–4)	3	2	(1–3)	5	2	(1–3)			11	4	(1–9)
Hodges	6	5	38	(3–93)							1	1							1	2	
Loveland	11	11	893	(20–2,368)	11	18	(1–32)				2	200	(160–240) †				1	1	2	1	
San Vicente	6	6	416	(50–1,140)															3	4	(2–5)
Sutherland	16	16	332	(34–735)				3	1.5	(1–2)											
Sweetwater	17	4	18	(3–42)				1	1										4	10	(1–23)
Upper Otay	10	10	39	(2–88)	4	6	(1–20)														
Wohlford	10	10	75	(34–177)	7	10	(2–25)				5	15	(2–100)								
Mathews	7	7	30	(5–75)																	
Totals	125	111	---	(2–2,521)	30			16			11			6			1		21		
Percent infected	--	88.8			24.0			12.8			8.8			4.8			0.8		16.8		

* N — Number of fish infected (incidence of infection). $\bar{X}$ — Mean number of parasites per infected fish. R — Range in intensity of infection. † — Estimate.

TABLE 2. **Parasites Occurring in Largemouth Bass, *Micropterus salmoides*, in 13 Southern California Reservoirs.**

Reservoir	Number examined	*Posthodiplostomum minimum*			*Clinostomum marginatum*			*Proteocephalus ambloplitis*			*Proteocephalus* sp.			*Contracaecum* sp.			*Southwellina hispida*			*Myzobdella moorei*		
		N*	$\overline{X}$	R	N	$\overline{X}$	R	N	$\overline{X}$	R	N	$\overline{X}$	R	N	$\overline{X}$	R	N	$\overline{X}$	R	N	$\overline{X}$	R
Barrett	10	10	1,931	(61–5,730)	3	10	(1–27)															
El Capitan	13	10	80	(1–566)																		
Henshaw	10	10	814	(78–2,245)	3	3	(1–4)				3	5	(1–12)	8	18	(1–90)				6	4	(1–10)
Hodges	13	13	279	(1–855)	1	1					8	33	(6–98)	6	3	(1–11)						
Loveland	22	22	1,044	(192–2,880)	21	14	(3–40)										4	5	(1–11)	1	1	
Lower Otay	10	10	126	(72–168)	3	2	(1–4)	7	4	(1–10)	9	30	(11–60)	6	3	(1–4)						
Miramar	16	16	250	(8–1,017)				7	3	(1–7)	16	100	(20–300)†							1	1	
San Vicente	12	12	23	(5–154)	4	4	(2–6)				12	55	(15–250)†							7	2	(1–4)
Sutherland	41	39	342	(1–1,981)	10	3	(1–13)							1	1							
Sweetwater	6	6	403	(192–852)										1	8					5	9	(1–35)
Upper Otay	12	12	29	(4–106)	2	1											1	1		2	1	
Wohlford	10	10	346	(73–1,221)	8	6	(2–11)				10	75	(30–200)†									
Mathews	10	10	35	(1–96)	1	6					10	100	(30–300)†	10	8	(1–17)				3	1	
Totals	185	180	---	(1–5,730)	56			14			68			32			5			25		
Percent infected	--	97.3			30.3			7.6			36.7			17.3			2.7			13.5		

* N — Number of fish infected (incidence of infection). † — Estimates. $\overline{X}$ — Mean number of parasites per infected fish. R — Range in intensity of infection.

List 2. PARASITES BY HOST SPECIES

CLUPEIFORMES

Clupeidae

Dorosoma pentenese (Gunther), threadfin shad (15/26)

Digenea: **Clinostomum marginatum* (Rud. 1819), Leidy 1856

CYPRINIFORMES

Cyprinidae

Cyprinus carpio Linnaeus, carp (5/9)

Monogenea: *Dactylogyrus extensus* Mueller and Van Cleave 1932

Notemigonis crysoleucas (Mitchill), golden shiner (4/9)

†*Myzobdella moorei* (Meyer 1940) Meyer 1946

SILURIFORMES

Ictaluridae

Ictalurus catus (Linnaeus), white catfish (5/8)

Digenea: **Clinostomum marginatum* (Rud. 1819) Leidy 1856(1)

Monogenea: *Cleidodiscus pricei* Mueller 1936 (5)

Ictalurus melas (Rafinesque), black bullhead (5/10)

Digenea: **Clinostomum marginatum* (Rud. 1819) Leidy 1856 (5)

Monogenea: *Cleidodiscus pricei* Mueller 1936 (5)

Ictalurus natalis (LeSueur), yellow bullhead (4/4)

Monogenea: *Cleidodiscus pricei* Mueller 1936

Ictalurus nebulosus (LeSueur), brown bullhead (2/5)

Digenea: **Hysteromorpha triloba* (Rud. 1819) Lutz 1931 (3/3) these were collected by Olson in 1957.

Monogenea: *Cleidodiscus pricei* Mueller 1936 (2)

Ictalurus punctatus (Rafinesque) channel catfish (26/31)

Monogenea: *Cleidodiscus pricei* Mueller 1936 (11)

Cestoda: *Corallobothrium fimbriatum* Essex 1927 (26)
Corallobothrium giganteum Essex 1927 (16)

Hirudinea: †*Myzobdella moorei* (Meyer 1940) Meyer 1946 (12)

PERCIFORMES

Centrarchidae

Lepomis cyanellus Rafinesque, green sunfish (10/12)

Digenea: **Clinostomum marginatum* (Rud. 1819) Leidy 1856 (1)
**Posthodiplostomum minimum* (MacCallum 1921) Dubois 1936 (8)
†**Uvulifer ambloplitis* (Hughes 1927) Dubois 1938 (5/6). These were not found in the 1966 survey but in Los Penasquitos Creek in 1969.

Monogenea: *Urocleidus furcatus* (Mueller 1937) Mizelle & Hughes 1938.

Cestoda: †*Bothriocephalus claviceps* (Goeze 1782) Rud. 1810 (2)
**Proteocephalus* sp. (6)

Hirudinea: †*Myzobdella moorei* (Meyer 1940) Meyer 1946 (2)

Lepomis macrochirus Rafinesque, bluegill (111/125)

Digenea: **Clinostomum marginatum* (Rud. 1819) Leidy 1856 (30)
**Posthodiplostomum minimum* (MacCallum 1921) Dubois 1936 (111)

Monogenea: *Urocleidus dispar* (Mueller 1936) Mizelle & Hughes 1938
Urocleidus ferox Mueller 1934
Urocleidus furcatus (Mueller 1937) Mizelle & Hughes 1938

Cestoda: *Bothriocephalus claviceps* (Goeze 1782) Rud. 1810 (16)
**Proteocephalus* sp. (11)

Nematoda: **Contracaecum* sp. (6)
**Eustrongylides* sp. (1)

Hirudinea: †*Myzobdella moorei* (Meyer 1940) Meyer 1946 (21)

Micropterus salmoides (Lacépède), largemouth bass (182/185)

Digenea: **Clinostomum marginatum* (Rud. 1819) Leidy 1856 (56)
**Posthodiplostomum minimum* (MacCallum 1921) Dubois 1936 (180)

Monogenea:	*Actinocleidus fusiformis* (Mueller 1934) Mueller 1937
	Urocleidus dispar (Mueller 1936) Mizelle & Hughes 1938
	Urocleidus furcatus (Mueller 1937) Mizelle & Hughes 1938
	Urocleidus principalis (Mizelle 1936) Mizelle & Hughes 1938
Cestoda:	*Proteocephalus ambloplitis* (Leidy 1887) (14)
	**Proteocephalus* sp. (68)
Nematoda:	**Contracaecum* sp. (32)
Acanthocephala:	†**Southwellina hispida* (Van Cleave 1925) Witenburg 1932 (5)
Hirudinea:	†*Myzobdella moorei* (Meyer 1940) Meyer 1946 (25)

Pomoxis annularis Rafinesque, white crappie (17/42)

Digenea:	**Posthodiplostomum minimum* (MacCallum 1921) Dubois 1936 (16)
Cestoda:	**Proteocephalus* sp. (1)
Nematoda:	**Contracaecum* sp. (1)
Hirudinea:	†*Myzobdella moorei* (Meyer 1940) Meyer 1946 (4)

Pomoxis nigromaculatus (LeSeur), black crappie (9/14)

Nematoda:	**Contracaecum* sp. (8)
Hirudinea:	†*Myzobdella moorei* (Meyer 1940) Meyer 1946 (6)

DISCUSSION

The reservoirs surveyed have been created and stocked by man during the 20th Century. The fish fauna and their parasites have been introduced from various areas of the United States (Smith 1896). The present parasite fauna has been determined by the species introduced with the fish, through water transfers, or by bird vectors, and by the presence of conditions suitable for life cycle completion.

Since water and fish transfers are now commonplace in southern California, it seems unlikely that restrictions will be successful in preventing the spread of parasites now present. Lake Mathews, which is the central distribution point for Colorado River water imports to San Diego County, contains eight of the most frequently occurring parasites, including *Proteocephalus* sp., which is likely the most damaging. Hence, any reservoir receiving Colorado River water will probably have infected fish if conditions are suitable. Birds are intermediate hosts for *P. minimum*, *H. triloba*, *C. marginatum*, and *U. ambloplitus*, so it seems unlikely that their range can be restricted effectively, since birds are unrestricted in their movements.

Of the parasites surveyed, *Clinostonum marginatum* and *Hysteromorpha triloba* are the only two which have caused concern to anglers by rendering the flesh undesirable for consumption.

Further studies of parasite distribution, intensity, and ecological relationships should provide useful information. The introduction of water from northern California via the State Water Project system may result in the introduction of additional parasite species.

ACKNOWLEDGMENTS

We extend our appreciation to Wilbur L. Bullock of the University of New Hampshire and Gerald D. Schmidt of the University of Northern Colorado for identifying the juvenile acanthocephalan; to Glenn L. Hoffman, Eastern Fish Disease Laboratory, Bureau of Sport Fisheries and Wildlife, Kearneyville, West Virginia, for assisting with some identifications, as well as offering suggestions regarding the manuscript; to J. Teague Self, University of Oklahoma, for loaning tapeworm specimens; and to John D. Mizelle, California State University, Sacramento, for identifying the monogenetic trematodes and reviewing our manuscript. We thank the San Diego Fish and Game Commission for its financial support of the field and laboratory work.

REFERENCES

Bailey, Reeve M. (editor). 1970. A list of common and scientific names of fishes of the United States and Canada. Spec. Publ. No. 6, American Fish. Soc., Washington, D.C. 150 p.

Colley, Frederick C. and Andrew C. Olson, Jr. 1963. *Posthodiplostomum minimum* (Trematoda: Diplostomidae) in fishes of Lower Otay Reservoir, San Diego County, California. J. Parasit. 49 (1) : 148.

Cooper, Arthur R. 1919. North American Pseudophyllidean cestodes from fishes. Illinois Biol. Monog. 4(4) : 288–541.

Crane, John W. and John D. Mizelle. 1968. Studies on monogenetic trematodes. XXXVII. A population study of two species of Ancyrocephalinae on the bluegill in California. J. Parasit. 54(1) : 49–50.

Edwards, Stephen R. and Fuad M. Nahhas. 1968. Some endoparasites of fishes from the Sacramento-San Joaquin Delta, California. Calif. Fish Game 54(4) : 247–256.

Haderlie, Eugene C. 1953. Parasites of the fresh-water fishes of northern California. Univ. Calif. Publ. Zool. 57 : 303–440.

Kritsky, Delane C. and John D. Mizelle. 1968. Studies on monogenetic trematodes. XXXV. Some new and previously described North American species of *Gyrodactylus*. Amer. Midl. Nat. 79(1) : 205–215.

Linicome, David R. 1943. Observations on the adult of *Arhythmorhynchus duocinctus* Chandler 1935 (Polymorphidae, Acanthocephala). Trans. Amer. Microscop. Soc. 62 : 69–71.

Miller, Lee W. 1967. A heavy infestation of the threadfin shad, *Dorosoma petenense*, by the yellow grub, *Clinostomum marginatum*, in El Capitan Reservoir, San Diego County, California. Calif. Fish Game, 53(4) : 293–294.

Miller, Richard L. 1967. Ecology of *Posthodiplostomum minimum* (Trematoda: Diplostomidae) in largemouth bass of southern California. M. A. Thesis, San Diego State College, San Diego. 61 p.

Mizelle, John D. 1962. Studies on monogenetic trematodes. XXII. *Dactylogyrus californiensis* sp. n. from the Sacramento squawfish. J. Parasit. 48(4) : 555–557.

Mizelle, John D. and John W. Crane. 1964. Studies on monogenetic trematodes. XXIII. Gill parasites of *Micropterus salmoides* (Lacépède) from a California pond. Trans. Amer. Microscop. Soc. 83(3) : 343–348.

Mizelle, John D. and Delane C. Kritsky. 1967*a*. Studies on monogenetic trematodes. XXXIII. New species of *Gyrodactylus* and a key to the North American species. Trans. Amer. Microscop. Soc. 86 : 390–401.

Mizelle, John D. and Delane C. Kritsky. 1967*b*. Studies on monogenetic trematodes. XXXVI. Gyrodactylid parasites of importance to California fishes. Calif. Fish Game 53(4) : 264–272.

Mizelle, John D. and H. D. McDougal. 1970. Studies on monogenetic trematodes. XLV. The genus *Dactylogyrus* in North America. Key to species, host-parasite and parasite-host lists, localities, emendations, and description of *D. kritskyi* sp. n. Amer. Midl. Nat. 84(2) : 444–462.

Mizelle, John D. and Charles E. Price. 1964. Studies on monogenetic trematodes. XXVII. Dactylogyrid species with the proposal of *Urocleidoides* gen. n. J. Parasit. 50(4) : 579–584.

Olsen, O. Wilford. 1962. Animal parasites and their biology and life cycles. Burgess Publish. Co., Minneapolis, Minn. 346 p.

Price, Charles E. and John D. Mizelle. 1964. Studies on monogenetic trematodes. XXVI. Dactylogyrinae from California with the proposal of a new genus, *Pellucidhaptor*. J. Parasit. 50(4) : 572–578.

Smith, Hugh M. 1896. A review of the history and results of the attempts to acclimatize fish and other water animals in the Pacific states. U.S. Fish Comm. Bull. 15(1895) : 379–475.

NOTES

WOLVERINE RECORDS IN THE PACIFIC COASTAL STATES AND NEW RECORDS FOR NORTHERN CALIFORNIA

A review of the literature shows that wolverines (*Gulo luscus*) were never abundant in California or in Oregon and Washington. Grinnell, Dixon, and Linsdale (1937) give seven locations where wolverine specimens have been collected, and 13 other records since 1900 plotted on a California map were all south of Lake Tahoe in the Sierras. According to Grinnell et al. (1937), in years prior to 1900, wolverines existed in northern California, based on one killed near Carberry Ranch, Shasta County, about 1893; and unverified records of wolverine near San Rafael, Marin County, 1855; and on Mill Creek near Healdsburg, Sonoma County, 1857.

Grinnell et al. (1937) estimated not more than 15 pairs of wolverine in California in 1933. The total population of these animals in California, Oregon and Washington must have been at its lowest ebb in the 1930's and 1940's.

Ingles (1965) states that the wolverine was very rare and was never common in California. He mentions one species located in northern Washington, absent from Oregon, and extending south in the Sierra Nevada Mountains to Walker Pass in Kern County, California. He mentions one seen at Squaw Valley in 1953, the first one observed for over a period of 6 years, and indicates that others have been reported from the high Sierras since then.

Kebbe (1966) published an account of one shot 11 September 1965 at Three-Fingered Jack Mountain in eastern Linn County, Oregon, which was the first record for Oregon since a wolverine was trapped in the same general area in 1912. He refers to several unverified reports "within the last five years" which indicate that this species still persists in the remote areas of the Cascades. Patterson and Bowhay (1968) present four records of wolverines in Washington: one shot April 12, 1963 near Grandview, Yakima County; one shot of two animals November 10, 1964 on American Ridge, Yakima County; and one trapped March 1, 1965 near the summit of Badger Mountain, Douglas County. Dalquest (1948) reported only five records for Washington, the most recent was a male trapped near Riverside, Okanogan County in 1941. Newby and McDougal (1964) reported a southerly range extension of wolverines in Montana.

For 20 years I have sought out records for this rare mustelid in the mountainous country of northern California. Only rumors of the occurrence of wolverine persisted until a former student, Dewey Rescione, reported one in 1966. Since then I have collected 12 records, which I consider reliable, Figure 1.

For Siskiyou County, California, I have eight records. One was seen at night in 1968 by Fire Control Officer Bob Wann of the Salmon River Ranger District on the road at Forks of the Salmon. Three were sighted

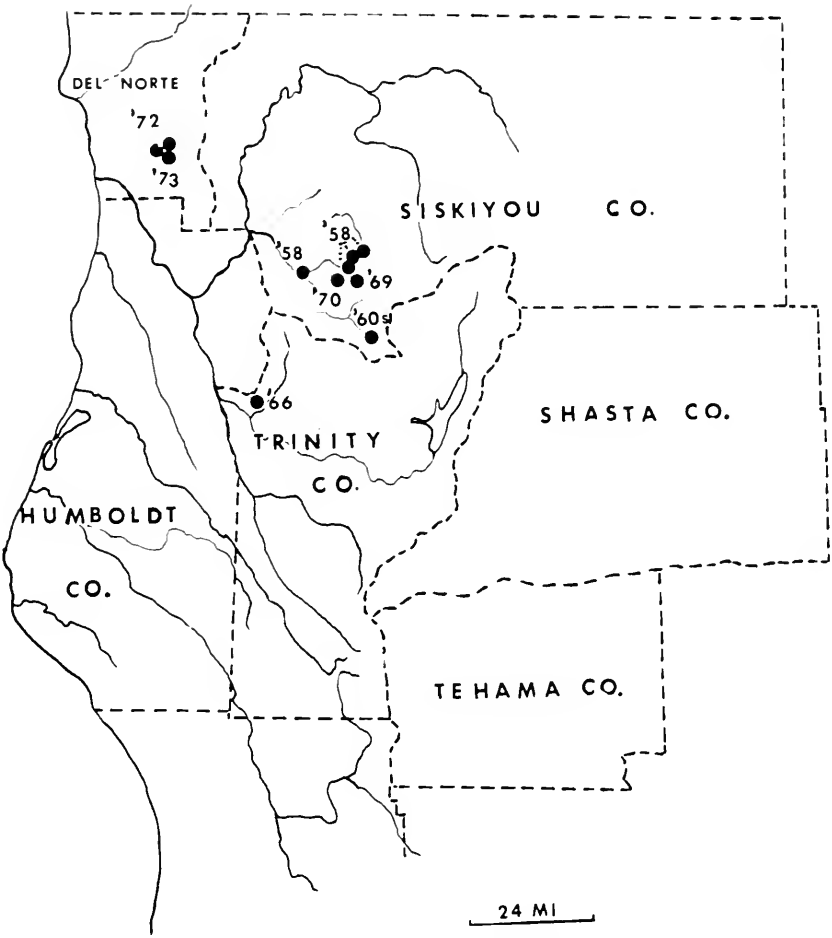

FIGURE 1. Dots indicate locations of wolverines seen in northwestern California. Numbers indicate the year observed.

during 1958 on the road up the North Fork of the Salmon River 1 to 3 miles east of Sawyers Bar by Assistant Fire Control Officer, Harvey Deala. One was seen in the 1960's in a field at the old townsite of Summerville (now the Lor-O-Ranch), Salmon River, 4½ miles southwest of Cecilville by Harvey Deala. In the winter of 1969, two were observed approximately 4 miles south of the confluence of White Gulch and North Fork of the Salmon River which is about 4 miles southeast of Sawyers Bar by Nels McBroom. Tracks of one animal were seen by Nels McBroom (H. J. Taylor, U.S.N.F.S.) on the road between Jessups Gulch and Eddy Gulch, 1 mile south of Sawyers Bar.

For Trinity County, California, I have a record of one seen at Hawkins Creek Bridge, S16 T6N R6E, 1½ miles north of Hawkins Bar (Dewey Rescione, U. S. N. F. S.).

For Del Norte County, California, I have three records. One near Muslatt Mountain on Ship Mountain—Quartz Creek Road, NE ¼ NW Sec. 21 T15N R3E by Darryll Smith and Pat Newman; David Garber, Wildlife Biologist, U. S. Forest Service, found wolverine tracks along Ship Mountain Road February 5, 1973; Pamela Bruce saw the same tracks February 24, 1973 (David Garber, U. S. N. F. S.).

The distribution map shows the three records on the west side of the Siskiyou Mountains in Del Norte County, the one record west of New River in mountainous Trinity County, and the cluster of seven records along the Salmon River in Siskiyou County north of the Salmon-Trinity Alps Wilderness.

Apparently, this rare species is becoming established in the Siskiyou, Klamath, Salmon, Trinity, Scott and Scott Bar mountains and Trinity Alps of northwestern California.

Records for Washington, Oregon and northern California indicate that wolverines may be increasing in abundance in these portions of their range since the late 1950's.

LITERATURE CITED

Grinnell, Joseph, Joseph S. Dixon, and Jean M. Linsdale. 1937. Fur-bearing mammals of California. Volume 1, Univ. of Calif. Press, Berkeley, 375 p.

Kebbe, Chester E. 1966. Wolverine killed in Oregon. The Murrelet 47(3): 65.

Ingels, Lloyd G. 1965. Mammals of the Pacific States. Stanford Univ. Press, Palo Alto, 506 p.

Newby, Fletcher E., and John J. McDougal. 1964. Range extension of the wolverine in Montana. J. Mammal. 45(3): 485–487.

Patterson, John R., and Ellis L. Bowhay. 1968. Four recent records of wolverines in Washington. The Murrelet 49(1): 12–13.

—*Charles F. Yocom, School of Natural Resources, California State University, Humboldt.* *Accepted for publication, March 1973.*

FIRST RECORD OF A GOLDEN EAGLE DEATH DUE TO AVIAN CHOLERA

Since 1946 annual outbreaks of avian cholera have been observed among some species of waterfowl wintering in California (Rosen 1971). Occasionally species other than waterfowl are killed by this disease by the ingestion of parts of carcasses containing the causative organism of avian cholera *Pasteurella multocida*. This method of transmission of the disease has been most evident in gulls. During an outbreak of cholera in the Florida Everglades 10 to 14 bald eagles (*Haliaeetus leucocephalus*) were seen engaged in scavenger activity on the victims, but none of the eagles were found to have succumbed. (Klukas and Locke 1970). However, one bald eagle did die at Tule Lake National Wildlife Refuge in 1971, and *P. multocida* was isolated from it (Rosen 1972).

Both bald eagles and golden eagles (*Aquila chrysaetos*) winter at the Tule Lake National Wildlife Refuge. These birds commonly feed on crippled waterfowl following the hunting season. In addition, it is estimated they feed on 25 to 30% of the total number of geese which have died of avian cholera. The eagles often scavenge within 24 hr after the geese have succumbed which is prior to the time that it is possible to pick up many of the carcasses from the fields and shorelines of the refuge.

Since 1963 the average early spring population in the Tule Lake Basin has been 59 bald and 11 golden eagles with maximum numbers recorded at 95 bald and 33 golden eagles. A number of these are southern bald eagles, sub-species *B. l. leucocephalus*, which is considered an endangered species. The low population of eagles could be further endangered by their scavenging proclivity.

During March 1973 a dead golden eagle was found at the base of a power line pole from which it had fallen at Tule Lake. The specimen was submitted by the Refuge to the Wildlife Investigations Laboratory of the California Department of Fish and Game. Heart blood was cultured on modified Das medium (Rosen 1972). *P. multocida* was isolated and identified in differential media. The organism was positive in indol, nitrate, and ornithine decarboxylase. It produced acid with no gas in glucose and sucrose. Negative reactions were observed in urea, lactose, maltose, glycerol, arginine decarboxylase; no growth occurred on MacConkey medium and it was nonmotile.

The isolate was typed by Heddleston's method of gel diffusion serology and found to be type 1 (Heddleston et al. 1972). The type isolated each year from waterfowl which die of avian cholera has always been type 1. There is conclusive evidence that the golden eagle succumbed to avian cholera as a result of ingesting waterfowl which had died of the same cause.

REFERENCES

Heddleston, K. L., J. E. Gallagher, and P. A. Rebers. 1972. Fowl cholera: gel diffusion precipitin test for serotyping *Pasteurella multocida* from avian species. Avian Dis. 16(4): 925–936.

Klukas, R. W., and L. N. Locke. 1970. An outbreak of fowl cholera in Everglades National Park. J. Wildlife Dis. 6: 77–79.

Rosen, M. N. 1971. Avian cholera. *In*: Infectious and parasitic diseases of wild birds, edited by Davis, J. W., R. C. Anderson, L. Karstad, and D. O. Trainer, Iowa State Univ. Press. p. 59–74.

Rosen, M. N. 1972. The 1970–71 avian cholera epornitic's impact on certain species. J. Wildlife Dis. 8: 75–78.

—*Merton N. Rosen and Karen D'Amico, California Department of Fish and Game and Edward J. O'Neill, U. S. Bureau of Sports Fisheries and Wildlife.* *Accepted April 1973. Supported in part by Federal Aid to Wildlife Restoration Project W-52-R "Wildlife Investigations Laboratory."*

AN ALBINO GREY SMOOTHHOUND *MUSTELUS CALIFORNICUS* GILL

Albinism in teleosts is a relatively well known phenomenon (Follett and Dempster 1966), but few examples of true albinism can be found for the elasmobranchs. Herald (1953) reported an albino sevengill shark (*Notorynchus maculatus*) from South San Francisco Bay. The specimen, however did not have pink eyes and is therefore not a true albino. Schwartz (in Joseph 1961) described albino cownose rays, *Rhinoptera bonasus* from Chesapeake Bay. The first record of an albino hammerhead shark, *Sphyrna lewini*, was reported by McKenzie (1970). He noted that the eyes were pink, proving it was a true albino.

On 3 July 1969 a male albino grey smoothhound, *Mustelus californicus*, measuring 263 mm, was taken by hook and line at Kirby Park, Elkhorn Slough, Monterey County, California, by an unknown fisherman. The specimen was kept for 3 days in an aquarium at the Moss Landing Marine Laboratories after which time it was placed in formalin and deposited in the fishes collection of the museum (MLML no. ES-4). The animal had pink eyes thus making it a true albino.

This is the second record for an albino grey smoothhound. The first record was reported by Herald, Schneebeli, Green and Innes (1960), also for Elkhorn Slough. They state that its eye color could not be determined. Its total length was 340 mm, making it older than the specimen being reported here.

Recently a pregnant grey smoothhound was caught in Elkhorn Slough which contained five albino embryos (Larry Talent, Moss Landing Marine Laboratories, pers. comm.). It seems therefore, that albinism in elasmobranchs may be more common than the literature indicates.

ACKNOWLEDGMENT

I wish to thank Larry Talent for his help with this article.

REFERENCES

Follett, W. I. and L. J. Dempster. 1966. Partial melanalbinism in a Scorpaenid fish, *Sebastodes melanstomus* Eigenmann and Eigenmann, from Monterey Bay, California, with selected references to melanism and albinism in fishes. Wassmann J. Biol. 24 (2) : 189–198.

Herald, Earl S. 1953. The 1952 shark derbies at Elkhorn Slough, Monterey Bay and at Coyote Point, San Francisco Bay. Calif. Fish Game 39 (2) : 237–243.

Herald, E. S., W. Schneebeli, N. Green and K. Innes. 1960. Catch records for seventeen shark derbies held at Elkhorn Slough, Monterey Bay, California. Calif. Fish Game 46 (1) : 59–67.

Joseph, Edwin B. 1961. An albino cownose ray, *Rhinoptera bonasus* (Mitchell) from Chesapeake Bay, Copeia (4) : 482–483.

McKenzie, Michael B. 1970. First record of albinism in the hammerhead shark, *Sphyrna lewini* (Pisces: Sphyrnidae). J. Elisha Mitchell Sci. Soc. 86 (1) : 35–37.

—*Joel L. Cohen, Moss Landing Marine Laboratories, Moss Landing, California 95039. Present address: 57 Lincoln Road, Brooklyn, New York 11225.*

BOOK REVIEWS

Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms

By J. E. Bardach, J. H. Ryther, and W. O. McLarney; John Wiley and Sons, Inc., New York, N.Y. 1972; xii + 868 p., illustrated. $37.50.

Aquaculture, defined here as the farming of aquatic organisms for human consumption, is undergoing a phenomenal world-wide expansion in response to our ever-increasing need for protein sources. Commensurate with this growth is the development of a plethora of new techniques and knowledge. Recognizing a need to collate this wealth of information into one reference source, the authors accepted a challenge to compile an "encyclopedia of aquacultural practices." They have reviewed the world-wide literature on freshwater and marine aquaculture and conducted extensive interviews and personal communications with individuals in the many areas of specialization. The work is restricted to human aquatic food species, both plant and animal. The result of their effort is more than a compendium or outline on the subject; it is a comprehensive, detailed treatment of current aquaculture practices on a world-wide, species by species basis—a seemingly impossible task successfully accomplished.

An introductory chapter presents a concise discussion of biological principles underlying the practice of aquaculture, the types of aquacultural practices, desirable characteristics in a cultured organism, and general economics and prognosis for aquaculture. There follows 42 chapters on the culture of freshwater and marine plants and animals. Each chapter considers either a single major species or a group of taxonomically or environmentally related species. Three chapters provide a lengthy discussion on the many cultural techniques for common, Chinese, and Indian carps. A chapter describes early attempts at fish farming in the south-central U.S. using buffalofish and paddlefish. Catfish culture on a world-wide scope is the subject of two chapters. Seven chapters detail the culture of gourami, Asian, African, and Latin American pond fishes, milk fish, *Tilapia*, and true eels. Experimental culture in Australia is discussed. Pike, perch, bass, sunfish, mullet and similar fishes are the subject of three chapters. As could be expected, two lengthy chapters describe in detail the commercial and experimental culture of freshwater and anadromous salmonids. A short chapter summarizes the culture of coregonid fishes in the Soviet Union. Smelt, sturgeon, shad, and European cyprinids occupy four chapters. Five survey the culture of brackish water and marine fishes, such as pompano, yellowtail, and flatfish. Ten explore the shellfish—from shrimp and crayfish to marine gastropods and squid, with the chapter on oyster culture approaching the status of a definitive treatise. The farming and indoor culture of frogs are given ample coverage. Edible freshwater plants and seaweeds are the subjects of the final two chapters.

Various aspects of culture, detailing propagation, rearing, harvest, and economic considerations, are covered for each species or group. Emphasis is placed on describing current practices and techniques. Most chapters include a prospectus statement. References are listed at the end of each chapter as are the pertinent data on interviews and personal communications. Tables, figures, and illustrations are of high quality, numerous, and skillfully support the text. There is a subject index, an index of plant and animal names, and an index of persons, places, and institutions. Unfortunately, it takes time to publish such a monumental volume. Literature since 1970 is not included, and this prematurely dates any such work in this rapidly developing field. Nevertheless, the book is the first comprehensive treatment of world-wide aquaculture in English and should soon become a "classic."

The authors have been successful in eliminating the generalities that could easily infiltrate and detract from a massive survey work. It is a technical book, factual, specific, but easily read. In my opinion it belongs in the library of anyone associated with the culture of aquatic organisms. Although specifically oriented to aquacultural techniques, the book contains a wealth of biological data that will warrant its use as a reference text by all fishery and aquatic biologists.—*Keith R. Anderson*

Diseases of Fish.

Symposia of the Zoological Society of London, number 30, edit. by L. E. Mawdesley-Thomas, Academic Press Inc., N. Y. 1972; 380 p. illustrated, $21.00.

The title is that of a symposium held in 1971 by the Zoological Society of London and the Fisheries Society of the British Isles and it is more appropriate as such than when applied to this book.

The volume includes contributions by some of the leading workers in the field of fish diseases. In the 16 chapters a rather wide group of subjects are treated, some of which are: Progress in Fish Pathology in this Century by S. F. Snieszko, Some Aspects of Mycobacterial Infections in Fish by H. H. Reichenbach-Klinke, Ulcerative Dermal Necrosis of Salmon (*Salmo salar L.*) by Ronald J. Roberts, Studies on the Haematology of the Atlantic Salmon (*Salmo salar L.*) by D. A. Conroy, Some Characteristics of Antibodies in the Primary Immune Response of Rainbow Trout (*Salmo gairdneri*) by Michal Dorson, The Principles of Therapy in Fish Diseases by Roger L. Herman, Some Histological Techniques Applicable to Fish Tissues by David Bucke, Advances in Fish Virology: A Review of 1966–1971 by Ken Wolf and Rearing of Marine Fish—Problems of Husbandry, Nutrition and Disease by Ian D. Richardson. Two chapters, one by Lionel E. Mawdesley-Thomas and the other by John C. Harshberger, deal with tumours of fish and work of the Registry of Tumours in Lower Animals with emphasis on fish neoplasms. These will be especially of interest and value to those interested in histopathology and neoplasms.

From the above it is seen that this volume will not be of use to the fish culturist or commercial fish farmer interested in caring for his crop but rather for the fish disease specialist or researches. For such workers, this book will be most helpful.—*Harold Wolf*

Gifts of An Eagle

By Kent Durden; Simon and Schuster, New York, N. Y. 1972; illustrated, 160 p., $5.95

Gifts of An Eagle is an intriguing account of the experiences of a father and son with a golden eagle taken as a nestling and retained in captivity for 16 years.

The story provides insight into the intelligence and behavior of the eagle "Lady" and explains why since Medieval times man has been captivated by birds of prey.

It is one of those relaxed readings a person cannot put aside until the final pages are read. I highly recommend this book as an addition to your library and assure you it will be read many times.—*Howard R. Leach*

This Wonderful World of Trout (revised edition)

By Charles K. Fox; Freshet Press, Rockville Centre, N.Y., 1972; x + 338 p. illustrated. $9.95.

At long last, this fly fisherman's classic has been reprinted. This edition has an introduction by Ernie Schweibert and incorporates some new material, although I was unable to locate a 1st edition to determine the extent of the new material.

The first part of the book discusses fly fishing history, flies, rods, casting, terrestials, and conservation methods necessary to develop quality fisheries in a series of informative, easy-to-read chapters. Part II consists of 15 delightful fishing stories. The price is fairly steep, but the book does contain a lot of information and many hours of enjoyable reading.—*K. A. Hashagen, Jr.*

Statistical Ecology, Vol. I, Spatial Patterns and Statistical Distributions.

Edited by G. P. Patil, E. C. Pielou and W. E. Waters. The Penna. State University Press, University Park, Penna. 16802. 1971; 582 p. $14.50.

This volume, the first of a 3 volume set, contains 23 papers which resulted from the proceedings of the International Symposium on Statistical Ecology. The purpose of the Symposium was to increase communications between quantitative ecologists, mathematicians and statisticians. The resulting papers, authored by many well known experts in this field, are advanced and sophisticated. Knowledge of calculus is essential to digest most of the papers.

Examples of some of the titles of interest to research and management biologists are: (i) Sampling strategy in censusing patchy populations; (ii) Properties of some discrete ecological distributions; (iii) Estimating parameters, testing fit, and analyzing untransformed data pertaining to the negative binomial and other distributions; (iv) On the estimation of fish population distributions using acoustic methods.

A comprehensive approach is not taken in the book since it was the result of a symposium. An index is also not evident in this volume, which detracts somewhat from its usefulness. The text on pages 62 and 63 is reversed which confuses the reader momentarily. This was the only error I noticed in a text which is easily read, considering the subject.

Those biologists, ecologists, and statisticians who are working with sampling populations and measuring population parameters will likely find this book extremely useful. It should be found on the shelf of any large resources-oriented library.—*Lee W. Miller*

RETIREMENT

LEO SHAPOVALOV

Leo Shapovalov, Senior Fishery Biologist and Assistant Chief of the Inland Fisheries Branch, retired from State service May 2, 1973.

Since his undergraduate days at Stanford University, where he deliberated between majors in English literature and biology, Leo has been a staunch advocate of clear and concise writing. Throughout his more than 40 years of service with our Department he has served as an eminent authority on matters of word usage, style, and punctuation in both popular and scientific articles. In addition to his talents for inspiring and guiding budding fishery scientists, he has authored more than 20 articles in our journal, *Science, Copeia, Transactions of the American Fisheries Society,* and others; coauthored 12 more; has written 68 administrative reports and coauthored 7 more; and has prepared a large number and variety of popular and semi-scientific articles. He served two 4-year terms as Editor-in-Chief of *California Fish and Game.*

Mr. Shapovalov, 65, joined the Department (then Division) as a research biologist in 1932. Following a variety of assignments, he headed the old Coast District as District Fisheries Biologist from 1944 through 1948. In 1949 he was promoted to Supervising Fisheries Biologist in charge of statewide inland fisheries research and management. He served in this capacity until the reorganization of the Department in 1952, and since then has been assistant chief of the branch.

He headed a 9-year salmon and steelhead research program which culminated in the publication of the well-known bulletin *The Life Histories of the Steelhead Rainbow Trout and Silver Salmon,* which won The Wildlife Society's award for the most outstanding publication in wildlife ecology and management during 1954–55.

In June 1970, Leo received a Safe Driving Award for 38 years and 500,000 miles of accident-free state auto operation.

Shapovalov is a fellow of the American Association for the Advancement of Science, the American Institute of Fishery Research Biologists, and the International Academy of Fishery Scientists, a charter member of The Wildlife Society, and a member of the Pacific Fishery Biologists, of which he was president in 1970, the American Fisheries Society, the Society of Ichthyologists and Herpetologists, and the honorary scientific fraternity Sigma Xi. He has also served as chairman or member of numerous national and regional committees of the American Fisheries Society, The Wildlife Society, and other organizations.

Leo's co-workers and many friends extend their best wishes for a long and happy retirement.—*George W. McCammon, Chief, Inland Fisheries Branch, California Department of Fish and Game*

ERRATA

Rawstron, Robert R., and Kenneth A. Hashagen, Jr. 1972. Mortality and survival rates of tagged largemouth bass (*Micropterus salmoides*) at Merle Collins Reservoir. Calif. Fish Game 58(3): 221–230.

We found Table 6 in the above paper to contain certain errors. The complete corrected table is given below. Values or statements used in the text should be replaced by those from the corrected table. Conclusions drawn about overexploitation of largemouth bass are not materially altered.

TABLE 6. Catch Statistics for Largemouth Bass at Merle Collins Reservoir, 1965–1970

Year	1965	1966	1967	1968	1969	1970
Total anglers	3,410	5,118	8,194	10,118	11,756	11,170
Total angler hours	13,007	17,376	27,801	35,930	48,222	52,860
Annual catch	4,388	7,062	7,682	3,582	2,300	1,937
Total weight	1,208	1,401	2,931	1,932	1,937	1,959
Mean annual weight	0.28	0.20	0.38	0.54	0.84	1.01
Catch per hour (all anglers)	0.27	0.31	0.28	0.10	0.05	0.04
Catch—March, April, May; June; Boat: lures, minnows, combination of lures and minnows†	138*	445	1,231	1,134	829	575
Hours (as above)†	577*	1,639	3,408	3,449	5,797	4,555
Catch/hour (as above)†	0.24*	0.27	0.36	0.33	0.14	0.13

* Includes June data only. Lake not open March, April, May.
† Observed values. All others are expanded values.

Love, Milton S. and John Vucci. 1973. Partial ambicoloration in three California flatfishes. Calif. Fish Game 59(2): 146–148.

In the above cited article a fish is illustrated and described in the text as a fantail sole. It is a diamond turbot, *Hypsopsetta guttulata* (Girard).

△84753—800 5-73 5,750

POSTMASTER: RETURN POSTAGE GUARANTEED
Editor, CALIFORNIA FISH AND GAME
CALIFORNIA DEPARTMENT OF FISH AND GAME
987 JEDSMITH DRIVE, SACRAMENTO, CA 95819

BULK RATE
U.S. POSTAGE
PAID
Sacramento, Calif.
Permit No. 949