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The equation on page 81 describing the length-weight relationship should be $W = 0.0002311L^{3.17941}$. In Table 7, page 81, the condition factor for the one fish with a length of 31.5 inches should be 51.5.

Calif. Fish and Game, 53 (4) : 228-245. 1967.

THE EASTERN PACIFIC GROUPERS OF THE GENUS *MYCTEROPERCA*, INCLUDING A NEW SPECIES[1]

RICHARD H. ROSENBLATT and BERNARD J. ZAHURANEC
Scripps Institution of Oceanography
University of California, San Diego
La Jolla, California

The genus *Mycteroperca* is represented in the Pacific Ocean by 5 species: *M. jordani*, *M. olfax*, *M. prionura* sp. nov., *M. rosacea*, and *M. xenarcha*. The species may be distinguished by color pattern, gill raker and fin ray number, and shape of the fins. *M. olfax* and *M. rosacea* have two color phases, speckled and golden. *M. xenarcha* ranges from San Francisco, California, to Peru; *M. jordani* is found from southern California to Mazatlan, Mexico; *M. rosacea* and *M. prionura* are known only from the Gulf of California and central Mexico; and *M. olfax* is restricted to the Galapagos Islands and the coast of Peru.

As currently recognized, the serranid genus *Mycteroperca* comprises 12 species, all of which occur in the Western Hemisphere, with 7 in the Atlantic (Smith, 1961) and 5 in the Pacific. Walford (1936) recognized 4 species of the genus in the Pacific, but our data indicate that the so called "red-spotted phase" of *M. xenarcha* represents a distinct and undescribed species. This paper names and describes this species (*M. prionura*), redescribes the related *M. xenarcha*, and gives sufficient data on the other Pacific species so that they can be identified with certainty. Measurements and counts utilized in the descriptions were made after the methods of Hubbs and Lagler (1964).

MYCTEROPERCA GILL

The genus *Mycteroperca* may be distinguished from other Eastern Pacific Serranidae (sea basses) by the following combination of characters:

Dorsal X or (usually) XI, 15-18, margin not deeply notched, and none of the spines exserted; anal soft rays 10-12; caudal rounded to lunate, or with a jagged rear margin; scales small, in 90-120 rows above the lateral line, roughly ctenoid to the touch; vertical limb of preopercle finely denticulate, with some enlarged spines at the angle, but without a large anteriorly directed spine just above the angle; body not strongly compressed.

Distribution.—Considering the wide distributions of other New World groupers (see for example Smith, 1961), several of the Pacific species of *Mycteroperca* appear to have surprisingly restricted distributions (Figures 1 and 2). The known range of *M. xenarcha* extends from northern Peru to northern California, but this is the only species with such a wide distribution. So far as known, *M. olfax* is limited to the Galapagos Islands and northern Peru, *M. jordani* ranges from

[1] Submitted for publication April 1967. Contribution from the Scripps Institution of Oceanography, University of California, San Diego, La Jolla, California.

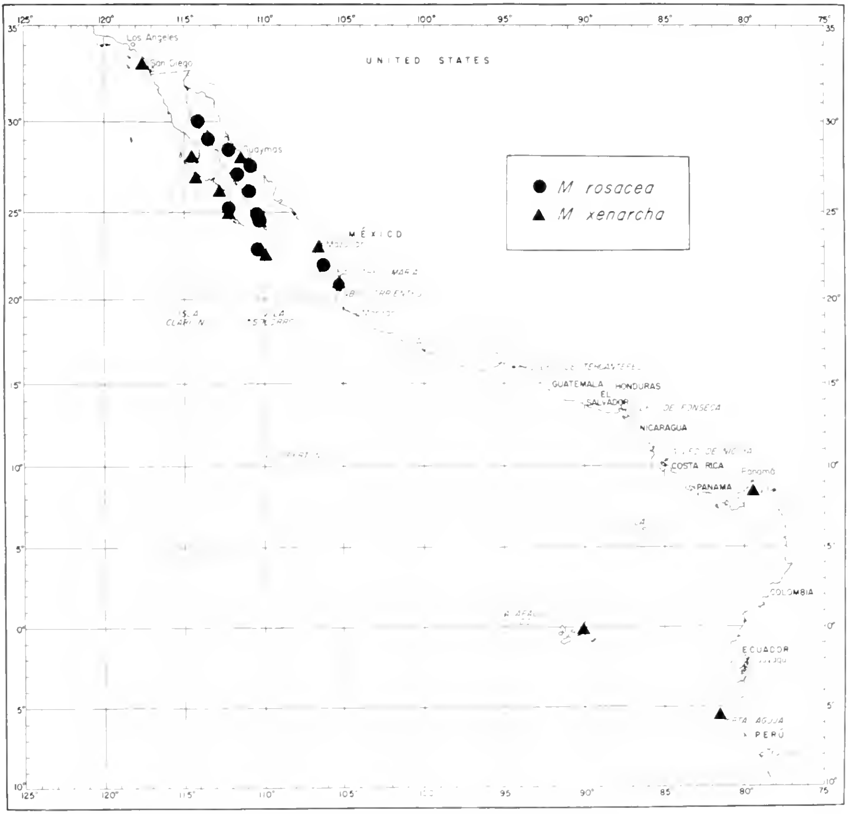

FIGURE 1—Some record localities for *Mycteroperca rosacea* and *M. xenarcha*. The San Francisco, California, record for *M. xenarcha* has not been plotted.

southern California to Mazatlan, and *M. rosacea* and *M. prionura* are limited to the Gulf of California and the adjacent Mexican Coast as far south as Bahía Banderas. It is not easy to account for these limited distributions, particularly since all of the species of *Mycteroperca* presumably have pelagic eggs and larvae (Smith, 1961). In support of this view, it is known that the spawning season for *M. rosacea* in the southern part of the Gulf of California ends by April (E. S. Hobson, pers. commun.), and the young do not appear inshore until late June or early July. We have no such information for the other species, but it might be noted that our smallest specimen of *M. jordani* (30 mm) has elongate preopercular and second dorsal spines, characters suggestive of the pelagic prejuvenile of other serranids.

It seems highly probable that few species of *Mycteroperca* occur along the coast of Central America, and that the paucity is related to ecological factors. *M. xenarcha* is commonly taken in mangroves, and the other species seem to be more often associated with rocks. Certainly the rocky-shore habitat is less well developed south of Mexico, but it must be pointed out that other rock-dwelling serranids, such as *Epi-*

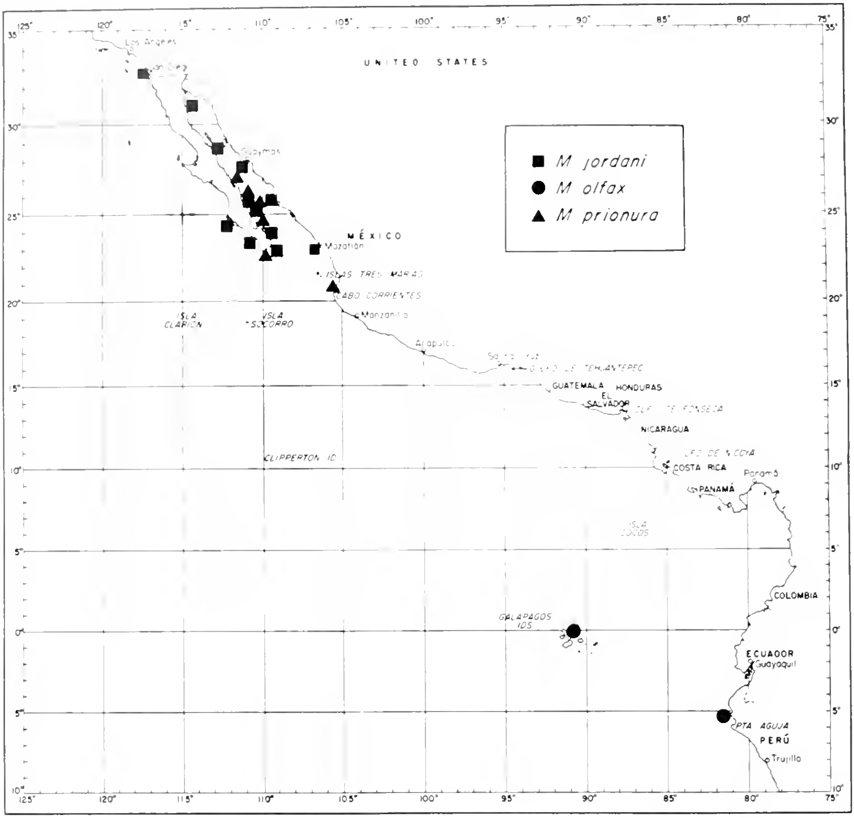

FIGURE 2—Some record localities for *Mycteroperca jordani, M. olfax,* and *M. prionura.*

nephelus labriformis, Petrometopon panamense, and *Paranthias colonus,* are found throughout the Panamic faunal area.

Ecology.—Little is known of the ecology of the Eastern Pacific species of *Mycteroperca.* All are presumably fish eaters as adults. This has been confirmed for *M. rosacea* (Hobson, 1966) and *M. olfax* (E. S. Hobson, pers. commun.), and a large adult *M. jordani* examined by us contained the remains of fishes, including the pharyngeal mill of a parrotfish (*Scarus* sp.). There is some indication that *M. prionura* is restricted to somewhat greater depths than other Eastern Pacific species of *Mycteroperca.* Of the hundred-odd juveniles taken in the Gulf of California by Scripps expedition "Pescado," only eight were from depths shallower than 25 feet. The center of abundance appeared to be between 50 and 60 feet. *M. prionura* was the only species taken as a juvenile as deep as 100 feet. Adults of *M. prionura* have been seen at 150 feet at Cabo San Lucas (R. Rosenblatt, observations from Cousteau Diving Saucer), and the holotype was taken in 135–150 feet. In contrast, juveniles of the other species have been taken in very shallow water. Young of *M. rosacea,* the most abundant grouper in the Gulf of California, are common in less than 20 feet of water, as are the adults. The few juveniles of *M. jordani* taken by us were all from 15 feet or less.

Large adults of *M. jordani* are likewise common in shallow water. Juveniles and adults of *M. xenarcha* are commonly taken in shallow water, although adults have been taken as deep as 150 feet. According to E. S. Hobson (pers. commun.) *M. olfax* is abundant in shallow water at the Galapagos Islands.

Taxonomy.—The Pacific species of *Mycteroperca* are similar in general body form, and variation in fin ray number is limited. The most useful characters for distinguishing the species are gill raker number, coloration, and outline of the dorsal and caudal fins. Each species can be characterized, and distinguished from its congeners, on the basis of gill raker counts. The means are different, and the ranges overlap little (Table 1). Coloration must be used with caution, as there is considerable variation. The most striking variability is found in *M. rosacea* and

TABLE 1

Total Gill Rakers on First Arch in Pacific Species of *Mycteroperca*

	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
M. jordani	5	2	5	11	6	2																	
M. olfax				1	1	4	9	6	4														
M. prionura														17	25	46	14	1					
M. rosacea																		8	11	11	6		1
M. xenarcha									3	3	18	11	2										

olfax, each of which has a golden color phase. This seems to be genetically controlled, as no adults have ever been observed to transform from the xanthic to the dark phase (although a piebald individual of *M. rosacea* has been taken), and the relative abundance of xanthic individuals does not seem to be correlated with habitat or depth. Color changes in the other species are less obvious, but in *M. jordani* and *M. xenarcha* the juveniles are marked with dark blotches, and the adults are usually plain, exhibiting a blotched color pattern only as a transitory phase. *M. prionura* is constantly spotted, but there is a transitory blotched color pattern in adults.

Fin shape is a useful character only for large juveniles or adults. In juveniles of all species, the soft dorsal is rounded and the posterior margin of the caudal is smooth. However, in *M. xenarcha* and *M. prionura,* beginning at lengths of about 150 mm and 250 mm, respectively, the posterior margin of the soft dorsal becomes pointed. In large adults of *M. xenarcha* a streamer is developed. In these two species, at about 200 mm, some of the caudal rays begin to elongate and become exserted, so that the rear margin of the tail has a jagged appearance. In adults of *M. xenarcha*, the exserted rays become long streamers. In similar fashion, the elongation of the second and third dorsal spines into a lobe characterizes large juveniles and adults of *M. olfax.* In *M. jordani,* the deep incision of the dorsal interspinous membrane also characterizes adults.

The following key will allow the identification of specimens of any size. Additional characters and special problems are discussed separately under each species.

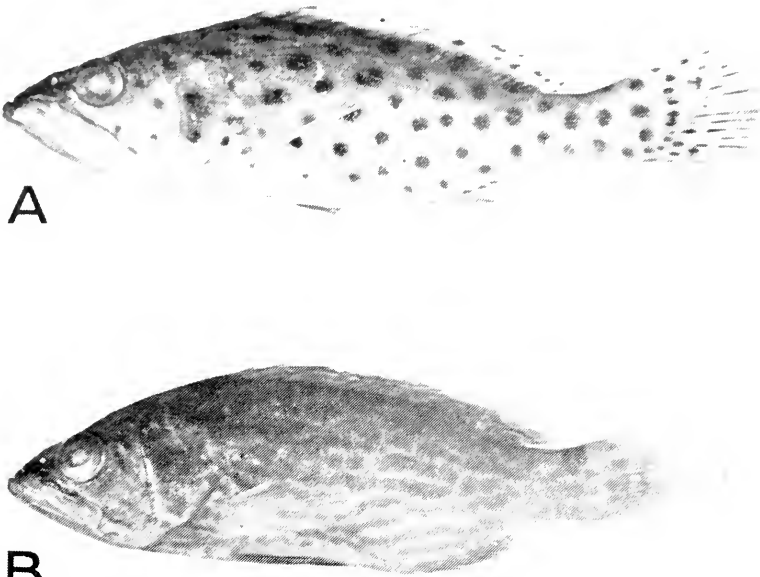

FIGURE 3—A, holotype of *Mycteroperca prionura*, SI066-48, 502 mm; B, *Mycteroperca xenarcha*. SI066-72, 696 mm. In both fish the light areas on the body and head indicate damage, as does the white streak on the caudal of the *M. xenarcha*.

Key to the Eastern Pacific Species of *Mycteroperca*

1a. Gill rakers on first arch 21–26 (rudimentary rakers cannot be enumerated on adults because of the development of many small plates at either end of the gill arch) ________ *M. jordani* (Jenkins and Evermann)

1b. Gill rakers on first arch 24–43 ________ 2

2a. Gill rakers on first arch 24–29. Second and third dorsal spines elevated above major outline of fin; third spine notably (0.3 to 1 orbit length) longer than fifth ________ *M. olfax* (Jenyns)

2b. Gill rakers on first arch 29–43. Dorsal spines evenly graduated; third spine little if at all longer than fifth (at most by 0.2 orbit length) ________ 3

3a. Body profusely covered with small spots or evenly golden (sometimes with melanistic blotches). Gill rakers on first arch 38–43 (modally 39–40). Posterior margin of caudal entire ________ *M. rosacea* (Streets)

3b. Body either mottled or polka-dotted in juveniles; plain, mottled, or with large brown dots in adults (Figures 3 and 4). Gill rakers on first arch 29–38. Posterior margin of caudal notched in individuals larger than 200 mm ________ 4

4a. Body plain gray or tan, or mottled with large irregular marks. Gill rakers on first arch 29–33. Pectoral rays 16–18, usually 17 .... *M. xenarcha* Jordan

4b. Body ground color bright tan; juveniles with large, round, reddish-brown dots, which become more numerous, irregular, and relatively smaller with growth. Gill rakers on first arch 34–38. Pectoral rays 15 or 16 .... *M. prionura* sp. n.

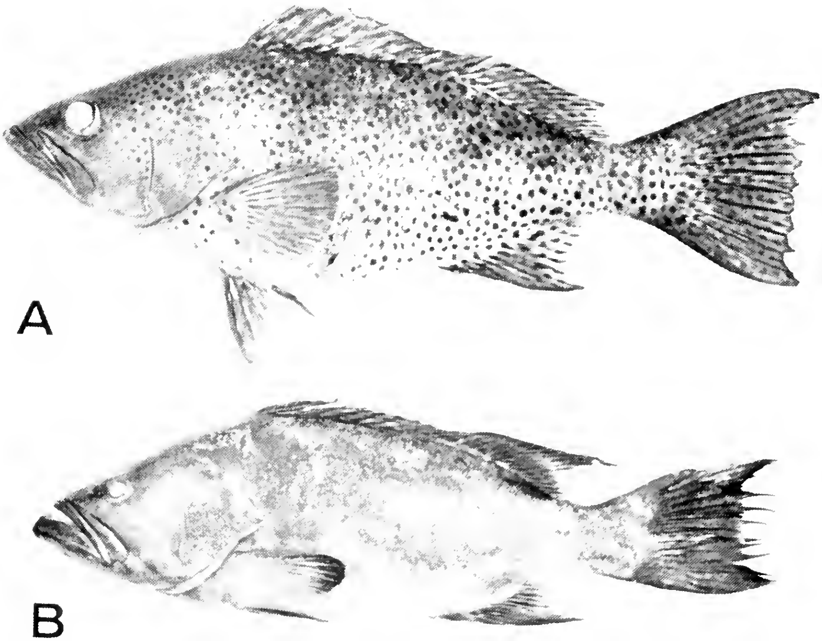

FIGURE 4—A, *Mycteroperca prionura*, paratype, SIO65-283, 75 mm; B, *M. xenarcha*, SIO64-86, 69 mm.

MYCTEROPERCA JORDANI (JENKINS AND EVERMANN)

Epinephelus jordani Jenkins and Evermann 1889: 140. Guaymas, Sonora.

Mycteroperca venadorum Jordan and Starks *in* Jordan 1895; 446. Mazatlan, Sinaloa.

Description

D XI, 16–17 (16.1); A III, 10–11 (10.8); pectoral 16–17 (17.0); gill rakers 21–26 (23.5). Vertical limb of preopercle convex for upper two-thirds of its length and weakly concave below, or evenly rounded; lobe at angle weakly developed or absent; in small individuals there are coarse denticulations, but in the 975-mm specimen the lobe is finely serrated. Maxilla extends to a point just behind vertical from rear margin of orbit, except in small juveniles, in which it does not quite reach to below rear margin of orbit. Posterior nostril not notably enlarged; its diameter 1.3–1.5 times that of anterior in subadults and adults, relatively smaller in juveniles. Lower jaw massive and protruding, forming an even continuation of the profile of the snout. Pectoral evenly rounded. Dorsal outline even; spines increasing in length to 4th and 5th, which are subequal, then decreasing gradually to 10th, which is slightly more than two-thirds as long as 5th; last spine about as long as 10th and three-fourths as long as 1st soft ray; spinous-dorsal membrane of adults deeply incised, so that distal half of middle spines is free. Posterior margin of soft dorsal rounded. Anal rounded in small juveniles; posterior margin oblique and forming a slight point where it meets the anterior margin in a 465-mm individual; anal pointed in a 975-mm individual. Fifth anal ray longest. Caudal rounded in young, lunate in largest individual; with margin smooth at all sizes. Squamation as in *M. prionura*. Scales on anterior part of upper back so small, imbedded, and irregularly arranged in our material that reliable counts are not possible.

Two color patterns. In some individuals the body and fins are plain brown or gray. In others there are large, dark gray, oblong blotches on the upper sides and on the fins. On the lower sides these blotches tend to break up into a reticulum, and the head is marked with dark streaks. Most, but not all, of the smaller specimens are in this color phase. As pointed out by Walford (1936), large individuals are usually plain dark brown or gray. However, a large adult (ca. 4 feet), which has been at the Scripps Institution of Oceanography Aquarium-Museum for 10 years, is capable of rapid changes in color pattern. Although usually plain brownish gray, it rapidly assumes the blotched color pattern if disturbed, or when food is introduced. A smaller (ca. 2 feet) individual in the same tank continually retains the blotched color pattern, but the markings are much intensified with excitement.

In all large individuals the pectoral margin is white, and there is a narrow white edging on the anal, caudal, and soft dorsal. These markings are much less prominent in juveniles.

Differential Diagnosis

The combination of smooth caudal margin, blotched or plain color pattern, 21–26 gill rakers, normally 17 pectoral rays, relatively evenly rounded opercular margin, with the lobe at the angle weak or absent, even outline of spinous dorsal, and rounded soft dorsal, distinguishes *M. jordani* from its congeners.

The gill raker counts of *M. jordani* overlap those of the allopatric *M. olfax*, and the characteristic elongation of the second and third dorsal spines is not obvious in small specimens of *M. olfax*. However, the color pattern of the juveniles of *M. jordani* consists of large, squarish, dark-gray blotches on a dark-gray background, whereas in *M. olfax* the ground color is reddish brown, and numerous reddish-brown spots are scattered over the body and fins. In addition the lobe at the lower angle of the preopercle is at most weakly developed in *M. jordani*.

Range

La Jolla, California, to Mazatlan, Mexico.

The occurrence of *M. jordani* in southern California has not previously been documented in the scientific literature. However, Carl L. Hubbs has been keeping records of captures of *Mycteroperca* for some time, and has allowed us to extract the following from his files. In early August 1945, four adults of *M. jordani* were taken in the inner part of the kelp bed at La Jolla, off Boomer Beach, two by spear and two on setlines. The speared fish, taken by Jack Prodanovich, weighed 73 and 110 pounds, respectively. Photographs of these individuals in Dr. Hubbs' files show enough features (rounded soft dorsal, smooth caudal margin, and short, widely spaced gill rakers) to make the identification certain. Information supplied by Jack Prodanovich and Wally Potts indicates that between September 1945 and January 1946 nine adults of *M. jordani* were taken off La Jolla. On February 14, 1951, Mr. Prodanovich took another *M. jordani* in the same area. It was 57.5 inches total length and weighed 117.5 pounds. The most recent capture was recorded on July 13, 1955, when a 91-pound *M. jordani* was taken at La Jolla by an angler. A photograph of this fish appeared in the San Diego Union on July 15, 1955. All of these fish were adults and there are no verified records of juveniles from California. From this, and the lack of recent records, it may be inferred that there is no breeding population in California and that the northern individuals are properly to be regarded as expatriates.

Material Examined

Mexico, Baja California Sur, west coast—Bahía Almejas, SIO62-119, 1(465); Punta Márquez, SIO62-703, 1(975). Mexico, Gulf of California—SIO65-289, 2(42-52); SIO65-296, 3(39-45); SIO65-297, 2(50-58); SIO65-328, 3(64-76); SIO65-331, 1(38); UCLA W51-3, 11(79-174); UCLA W53-94, 1(182); UCLA W56-116, 3(150-178); UCLA W60-60, 1(560).

MYCTEROPERCA OLFAX (JENYNS)

Serranus olfax Jenyns 1842: 9. Galapagos Archipelago.
Mycteroperca olfax ruberrima Jordan and Bollman, *in* Jordan and Eigenmann 1890:367. Abingdon Island, Galapagos.

Description

D XI, 16–17 (16.8); A III, 11 (11.0); pectoral 16–17 (16.5); gill rakers 24–29 (26.6). Vertical limb of preopercle gently convex for upper two-thirds to three-fourths of its length; lower one-fourth to one-third concave, with a denticulate lobe at the angle. Maxilla extending back to a vertical between midpoint of eye and rear margin of orbit. Nostrils subequal in juveniles; posterior one becoming enlarged with growth; in a 375-mm individual the diameter of the anterior nostril is half that of the posterior. Lower jaw protruding, but forming a slight angle with the contour of the snout. Pectoral evenly rounded. Second and 3rd dorsal spines subequal and elongated; 4th and 5th spines shorter; 5th shorter than 3rd by a distance equal to .3 to 1 orbit length; succeeding spines decreasing gradually in length to 10th which is somewhat less than two-thirds as long as 3rd; last spine equal to or slightly longer than 10th and about three-fourths as long as 1st soft ray. Soft dorsal outline rounded. Anal acutely pointed in specimens longer than about 250 mm; rounded in small juveniles; 5th ray longest. Caudal truncate in small individuals; slightly lunate in large ones, with posterior margin smooth. Squamation as in *M. prionura;* 92 scale rows in the Paita, Peru specimen and 96 in one from the Galápagos.

Two color phases, brown-spotted and xanthic. The coloration in life has been described by Walford (1936) as "typically dark olive-brown on back, sides and head, spotted with purplish and lighter brown . . . some specimens may be plain dark brown, others may have the body covered with faint circular dark brown spots." He described the xanthic phase as having the sides of the body orange-yellow, and the fin membranes chrome-yellow. We can add from our material that in the dark phase the fins are margined with white and that there is a dark-brown "moustache mark" above the maxilla.

Differential Diagnosis

The combination of smooth caudal margin, spotted or golden coloration, 24–29 gill rakers, 16 or 17 pectoral rays, elongate second and third dorsal spines, and rounded soft dorsal distinguishes *M. olfax* from its congeners.

M. rosacea resembles *M. olfax* in coloration, but has 38–43 gill rakers (Table 2) and its second and third dorsal spines are little if any longer

TABLE 2

Pectoral Rays in Pacific Species of *Mycteroperca*

	15	16	17	18
M. jordani	--	1	27	--
M. olfax	--	12	14	--
M. prionura	16	86	--	--
M. rosacea	1	19	2	--
M. xenarcha	-	3	28	2

than those immediately succeeding. The sympatric *M. xenarcha* also has more gill rakers (although there is some overlap) and usually fewer dorsal soft rays (Tables 1 and 3). In addition, in *M. xenarcha* the outline of the spinous dorsal is even, that of the soft dorsal pointed, the margin of the caudal is jagged, and the coloration is different. Even small juveniles whose counts fall in the zone of overlap can be distinguished on the basis of the spotted color pattern, the white fin margins, and the supramaxillary moustache mark of *M. olfax*. Because the gill raker counts of the allopatric *M. jordani* overlap those of *M. olfax*, juveniles may need to be distinguished on the basis of other characters, pointed out in the diagnosis of *M. jordani*.

Range

Galapagos Islands and Paita, Peru.

The range of *M. olfax* has erroneously been reported to include Panama (Jordan and Eigenmann, 1890; Walford, 1937; Seale, 1940)

TABLE 3

Dorsal Soft Rays in Pacific Species of *Mycteroperca*

	15	16	17	18
M. jordani	1	22	5	--
M. olfax	--	5	21	--
M. prionura	--	52	41	2
M. rosacea	--	2	17	3
M. xenarcha	19	14	--	--

and the Gulf of California. Seale is the only author to refer to an actual specimen of *M. olfax* from Panama, and in view of his wildly inaccurate statement that *M. olfax* is the most common grouper in the Gulf of California, his identification may be discounted. The only valid mainland record for *M. olfax* seems to rest on the Museum of Comparative Zoology specimen from Paita, Peru. The possibility that this individual may have actually come from the Galapagos Islands is discussed in the section on the range of *M. xenarcha*.

Material Examined

Ecuador, Galapagos Islands—SIO-H52-407, 1(263); SIO64-1009, 3(21-131); UCLA W53-141, 2(178-185); UCLA W53-142, 1(109); UCLA W54-225, 1(206); UCLA W56-10, 1(196); UCLA W64-1, 98-(24-245); Tokyo University of Fisheries, unnumbered, 7(210-375). Peru, Paita—MCZ 10223, 1(425).

MYCTEROPERCA ROSACEA (STREETS)

Epinephelus rosaceus Streets, 1877: 51. Gulf of California, "in the vicinity of Angel Island" [Angel de La Guarda].

Mycteroperca pardalis Gilbert, 1892:551. La Paz Bay, Baja California.

Description

D X, 16–18 (17.1); A III, 10–11 (11.0); pectoral 15–17 (16.0); gill rakers 38–43 (39.7). Vertical limb of preopercle gently convex for upper three-fifths to two-thirds of its length; lower portion weakly concave (exceptionally the concavity may be reduced to a notch); usually a weakly developed lobe at the angle. *M. rosacea* is quite variable in these characters; in most individuals a concavity and lobe are present, but in a few the preopercle is almost even. Maxilla, even in large adults, does not extend beyond rear margin of orbit. Posterior nostril enlarged only in very large adults; in a 475-mm specimen the nostrils are subequal, but in a 690-mm individual the diameter of the posterior nostril is about twice that of the anterior. Lower jaw protruding, but forming a slight angle with contour of snout. Pectoral rounded. Dorsal outline even; soft dorsal rounded; 3rd or 4th spine longest; succeeding spines gradually shortening to the 10th, which is three-fourths to four-fifths as long as the longest; last spine about equal to 10th, and somewhat less than two-thirds as long the 1st soft ray. Anal margin pointed; 5th or 6th ray longest; there is considerable variation in the development of the anal acuity (in specimens shorter than about 100 mm the anal is rounded, and the pointed shape is best developed in the larger examples; however, in a 410-mm specimen, 5th and 6th rays not much longer than the others and the point is very weakly developed). Caudal varying from truncate in small individuals to weakly lunate in large ones. Margin of caudal smooth. Squamation as in *M. prionura;* about 100 rows above lateral line in the one individual counted.

Two color patterns. Most commonly the ground color is greenish to olive-tan, and the head, body, and fins are profusely covered with small reddish-brown spots, so that the fish appears speckled. The pectoral fin has a broad white margin and the other fins are narrowly edged with white. About 1% of large juveniles and adults are xanthic; these individuals are bright yellow-orange, with the color most intense on the fins; some of them have melanistic blotches. We have observed and collected thousands of individuals of *M. rosacea* in the Gulf of California, and have never seen a xanthic individual smaller than 10–12 inches in total length. On several occasions individuals of about this size have been seen which exhibited faint spots beneath the orange-yellow, but adults have never been observed in this intermediate condition. Xanthic individuals definitely do not live at greater depths than spotted ones.

Differential Diagnosis

The combination of smooth caudal margin, spotted or golden coloration, 38–43 gill rakers, 15–17 (usually 16) pectoral rays, rounded soft dorsal, and even profile of spinous dorsal, distinguishes *M. rosacea* from its congeners. *M. rosacea* is likely to be confounded only with *M. olfax* or *M. prionura*, but can be distinguished by additional characters discussed in the diagnoses of those species.

Range

From Bahía San Luis Gonzaga, Gulf of California, and Bahía Magdalena, on the outer coast of Baja California, to Bahía Banderas, Jalisco, Mexico.

Material Examined

Mexico, Baja California, Bahía Magdalena—SIO62-100, 1(212); SIO62-727, 1(475); SIO64-55, 6(111–160). Mexico, Gulf of California—SIO59-228, 1(260); SIO59-235, 3(100–105); SIO61-228, 1(690); SIO61-253, 5(25–158); SIO61-260, 1(410); SIO61-279, 5(54–165); SIO61-280, 2(157–295); SIO62-233, 1(276); SIO65-260, 12(36–193); SIO65-319, 8(39–80); SIO65-326, 45(51–170); SIO65-351, 4(57–86); UCLA W52-74, 1(400); UCLA W60-16, 3(255–340). Mexico, Nayarit, Las Tres Marías, Isla San Juanito—SIO62-10, 1(358). Mexico, Jalisco, Bahía Banderas—SIO62-29, 1(252). In addition we have handled several thousand individuals of this species from the Gulf of California.

MYCTEROPERCA XENARCHA JORDAN

Figures 1, 3b, 4b, 5, 6

Mycteroperca xenarcha Jordan 1888: 387. James Island, Galapagos.
Mycteroperca boulengeri Jordan and Starks, in Jordan 1895: 445. Mazatlan, Sinaloa.

Description

D XI, 15–16 (15.4); A III, 10–11 (10.8); pectoral 16–18 (17.0); gill rakers 29–33 (31.2). Measurements of body parts are given in Table 4. Vertical limb of preopercle gently convex to almost straight for upper two-thirds to three-fourths of its length; lower part concave,

TABLE 4

Measurements of Body Parts Expressed as Thousandths of Standard Length, For *Mycteroperca prionura* and *M. xenarcha*

	M. prionura				*M. xenarcha*			
	R	$\overline{X}$	N	Holo-type	R	$\overline{X}$	N	Holo-type
Head length	367–435	393	15	378	361–413	375	31	389
Snout	103–219	120	15	109	89–119	101	28	095
Upper jaw	123–215	179	15	172	110–183	174	30	178
Orbit	060–119	092	15	060	040–098	071	28	060
Interorbit	068–087	077	14	087	044–098	078	28	088
Body depth at pelvics	286–356	307	15	335	302–353	326	31	302
Body depth at anal origin	248–313	271	15	289	281–318	303	28	291
Depth, caudal peduncle	100–120	109	15	114	116–136	126	31	116
Length, caudal peduncle	176–220	196	15	202	184–228	201	28	205
Pectoral length	202–254	229	15	202	147–260	224	28	212
Pelvic length	163–226	196	15	163	133–231	203	28	194
2nd dorsal spine	103–163	120	12	103	103–167	118	26	125
3rd dorsal spine	116–137	127	14	127	115–151	133	25	—
5th dorsal spine	103–156	115	15	114	107–152	129	26	124
Longest dorsal ray	137–158	146	14	149	166–223	183	28	191
Longest anal ray	120–185	148	15	185	165–222	194	28	193
Longest gill raker	039–053	046	14	045	035–056	045	28	049

with a pronounced denticulate lobe at the angle. Maxilla extends to a point opposite or just behind rear margin of orbit in adults; to behind rear margin of pupil in juveniles. Lower jaw massive and protruding, forming an even continuation of the slope of the snout. Posterior nostril not much enlarged; in our largest specimens the diameter of the posterior is only 1.3–1.5 times that of the anterior. Pectoral rounded, but with increasing size of fish the second to fifth rays tend to become relatively longer, so that the outline becomes more square; in the 1125-mm individual the upper corner is pointed. Dorsal outline even; first three spines graduated; 3rd and 4th subequal; succeeding spines gradually shortening to 10th, which is about three-fourths as long as 3rd; last spine slightly longer than 10th and two-thirds to three-fourths as long as 1st soft ray. Posterior margin of dorsal rounded in juveniles smaller than 150 mm; at about this size the 9th through 11th soft rays begin to elongate so that the fin becomes pointed, and in adults there is a trailing, almost filamentous tip; 9th ray longest. Below the pointed tip the outline of the anal is straight, or with a slight posterior slope; anal rounded in specimens to about 100 mm long, then becoming acutely pointed, increasingly so with size; 5th or 6th anal ray longest. Caudal truncate to rounded in juveniles; with growth the tips of the caudal rays become exserted and pointed, so that the posterior margin first has a jagged, ragged appearance, and then bears streamers (our material does not cover the size range at which the change occurs, but the caudal margin is entire in specimens in the 150–160 mm size range, and is jagged in one of 239 mm).

Two color patterns. In the blotched phase the color is brown, gray, or, according to Walford (1937), gray-green, with many oblong blotches on the upper sides, and elongate irregular marks on the lower sides; the head is mottled and streaked; in juveniles there is a conspicuous black blotch on the dorsal surface of the caudal peduncle. In the plain color phase the body is plain gray or brown; the fins are dusky and narrowly margined with white; the white edging of the pectoral is variable and may be well developed. All of our specimens are blotched except for the largest, and another (394 mm), from S1065-118, which is very faintly marked. The 425-mm holotype was described as plain brown. It is likely that, as in *M. jordani*, large individuals are mostly plain, but may assume the blotched color pattern under certain conditions.

Differential Diagnosis

The combination of exserted caudal rays, mottled or plain color pattern, 29–33 gill rakers, and pointed outline of soft dorsal distinguishes *M. xenarcha* from all its congeners. In addition, it is the only Pacific species of *Mycteroperca* that commonly has as few as 15 dorsal soft rays. *M. xenarcha* is mostly likely to be confused with *M. olfax* or *M. prionura*; the differences are discussed in the diagnoses of those species.

Range

San Francisco Bay, California to Paita, Peru, and the Galapagos Islands.

Although *M. xenarcha* has previously been recorded from southern California (California Bureau of Marine Fisheries, 1949; Radovich, 1961), the recent capture of an individual in San Francisco Bay, well to the north of Point Conception, California (the boundary of the warm temperate area) is surprising. Although neither a specimen nor photograph is at hand, Jack W. Schott of the California Department of Fish and Game transmits the following information. A 20-pound individual was taken in San Francisco Bay (inside Golden Gate) by a sport fisherman on the boat *Paul G.* on September 8, 1966. The captain, Bill Beckett, who reported the catch, formerly had been employed by the Department of Fish and Game and is familiar with *M. xenarcha*. Taken on the same day by the *Paul G.* were 2 cabezon (*Scorpaenichthys marmoratus*), 3 lingcod (*Ophiodon elongatus*), 60 striped bass (*Roccus saxatilis*) and 69 rockfish (*Sebastodes* spp). Several captures of *M. xenarcha* have been recorded in southern California, mostly in the vicinity of San Diego, from 1945 to the present. However there is no evidence that the population is capable of successful reproduction in California. As all California captures of this species and *M. jordani* have been of adults, California individuals are properly to be regarded as expatriates.

Although the type locality of *M. xenarcha* is James Island, Galapagos Islands, the species has not been taken at the Galapagos since, despite much subsequent collecting. It may be of some significance that the only Peruvian record of *M. olfax* is a specimen also taken on the Hassler Expedition. It is tempting to speculate that locality labels were somehow switched on these two specimens. However, there is nothing in the catalogs at the Museum of Comparative Zoology to confirm this speculation. Although the two are in the same bottle, each bears what appears to be an original field label indicating James Island as the locality for the holotype of *M. xenarcha* and Paita, Peru as the locality for the *M. olfax*.

Material Examined

California, San Diego County, Solana Beach—SIO66-297, 1(1158). Mexico, Baja California Sur—Bahía Sebastián Vizcaíno, SIO-H52-117, 2(138–161); Puerto San Bartolomé, SIO-H48-51, 1(151); Bahía San Juanico SIO-H50-182, 3(59-80); vicinity of Bahía Magdalena, SIO-H50-184, 1(105); SIO62-95, 1(450); SIO62-104, 1(374); SIO62-107, 1(465); SIO62-116, 2(340-370); SIO62-121, 1(59); SIO62-719, 2(51-61); SIO64-50, 2(317-322); SIO65-182, 9(77-393). Mexico, Gulf of California, Guaymas, UCLA W52-35, 1(134); Inner Gorda Bank, SIO66-72, 1(696); Cabo San Lucas SIO66-9, 1(670). Mexico, Sinaloa, Mazatlan—USNM 47481, 1(165). Mexico, Nayarit, Ensenada Chacala—UCLA W58-5, 2(320-380). Panama, Canal Zone—USNM 127857, 1(210); USNM 80252, 1(213). Peru, Paita—MCZ 10061, 1(345). Ecuador, Galapagos Islands, James Island—MCZ 24198, 1(365) (holotype).

MYCTEROPERCA PRIONURA SP. N.

Figures 2, 3a, 4a, 5, 6

Mycteroperca xenarcha, not of Jordan, Walford 1936: 6 (in part, "spotted phase" only). Walford 1937: 103, pl. 11, fig. C (in part, "spotted phase" only).

Description

Measurements of body parts are given in Table 4. D X-XI (10.98), 16–18 (16.5); A III, 10–12 (11.0); pectoral 15–16 (15.9); gill rakers 34–38 (35.6). Vertical limb of preopercle gently convex for upper two-thirds of its length; lower third slightly concave, with a denticulate lobe at the angle. Maxilla extends to a vertical from just behind edge of pupil in juveniles, to behind rear margin of orbit in adult. Posterior nostril not greatly enlarged; nostrils subequal in juveniles; diameter of posterior nostril about 1.5 times that of anterior in the holotype. Lower jaw protruding, forming an even continuation of the snout profile. Pectoral rounded in juveniles, but in the holotype the 3rd and 4th rays are almost as long as the 5th, forming an angle with the lower rays. Spinous dorsal outline even, without elongated spines or a pronounced notch; first three spines graduated; succeeding spines gradually shortening to 10th, which is almost three-fourths as long as 3rd; last spine slightly longer than 10th and about three-fifths as long as 1st soft ray. Ninth dorsal soft ray longest; 9th and 10th slightly exserted in holotype, to form an acute point; behind this point the outline of the fin is strongly concave, then with an oblique posterior slope. The point is barely noticeable in a 260-mm specimen, and in smaller individuals the dorsal is rounded. Anal margin acutely pointed in specimens of 260 mm and larger; rounded in small juveniles. Fourth anal ray longest. Tips of caudal rays acute and slightly exserted, so that caudal margin has a jagged, saw-toothed appearance in large individuals; this feature is discernible in a 260-mm specimen, but not on one of 170 mm. Entire body and head scaled; fine scales basally on fins; body scales small, in crowded irregular rows anteriorly, and difficult to enumerate with repeatability; rows above the lateral line, counted on seven specimens, range from 85–109.

Body ground color yellowish tan. In juveniles shorter than about 100 mm the body is marked with regular, round, reddish-brown dots, which are circular and rather regularly spaced, so that the fish has a polka-dotted appearance. The spots on the head are more sparse, especially ventrally, and smaller. There is a thin brown moustache mark over the maxilla. A dark stripe runs forward and slightly downward from the anterior margin of the eye, across the upper lip, and onto the lower jaw at the tip; occasionally the entire tip of the lower jaw is dark.

With increasing size relatively much smaller spots appear and take over the color pattern; and the fins become darker. In the adult holotype the body, dorsal, anal, and caudal fins are covered with subequal spots, and the dusky pectorals and pelvics are irregularly spotted. The pectoral is margined with a narrow white band. As in the juveniles, the spotting is sparser on the head. The anterior parts of the head are dusky, with spots dorsally and on the upper lip. According to the collectors, the holotype when captured had several large dusky blotches on the upper sides. These faded upon death and are now but faintly visible. The large blotches may be part of the normal adult color pattern of *M. prionura*. An Ektachrome transparency of a large (ca. 3 feet) living adult, taken under water at Cabo San Lucas, Baja California, shows about a dozen dusky roundish blotches along the sides and upper back.

Discussion

Walford's (1936; 1937) description and illustration of the "spotted Broom-Tail Grouper" certainly refer to this species. His figure shows the color pattern and the characteristic outline of the soft dorsal and anal. One of Walford's two specimens (USNM 101061) has been examined and is included in the type material of *M. prionura*.

Differential Diagnosis

The combination of exserted caudal rays, spotted color pattern, 34–38 gill rakers, 15 or 16 pectoral rays (see Tables 2 and 3), even spinous dorsal outline and distinctive contour of the soft dorsal, distinguishes *M. prionura* from its congeners.

M. prionura has been confused with *M. xenarcha*, probably because the caudal rays are exserted in each species. The obvious differences in color pattern have been attributed to variability. However, our data show that the two forms differ in mean number of dorsal and pectoral rays (Tables 1 and 2), and that there is a non-overlapping difference in gill raker number (Table 3). In addition, the rays that form the acute tips of the soft dorsal and anal are shorter in *M. prionura*. This is demonstrated graphically when the relative lengths of the longest dorsal and anal rays are plotted against standard length (Figures 5 and 6). The values do not overlap when individuals of similar sizes are compared. It is possible that young of *M. prionura* may be confused with those of the sympatric *M. rosacea*, since both are spotted. However the spotting is quite different. In *M. rosacea* the spots are small and scattered at random, whereas in *M. prionura* the spots are larger, bolder, and more regularly arranged.

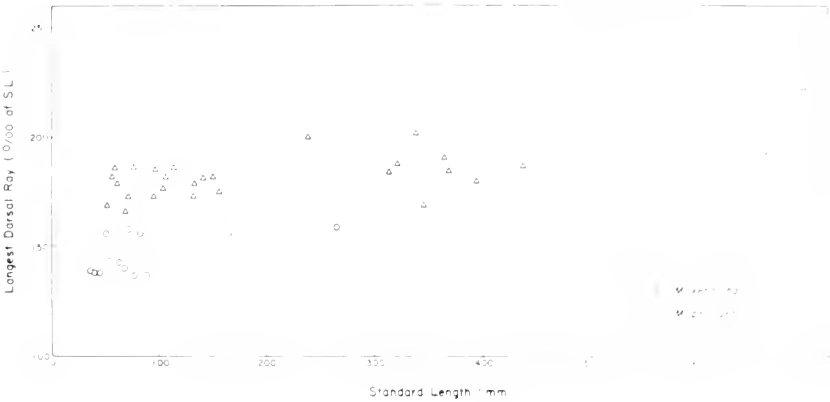

FIGURE 5—Length of longest dorsal ray expressed as thousandths of standard length vs. standard length in *M. xenarcha* and *M. prionura*.

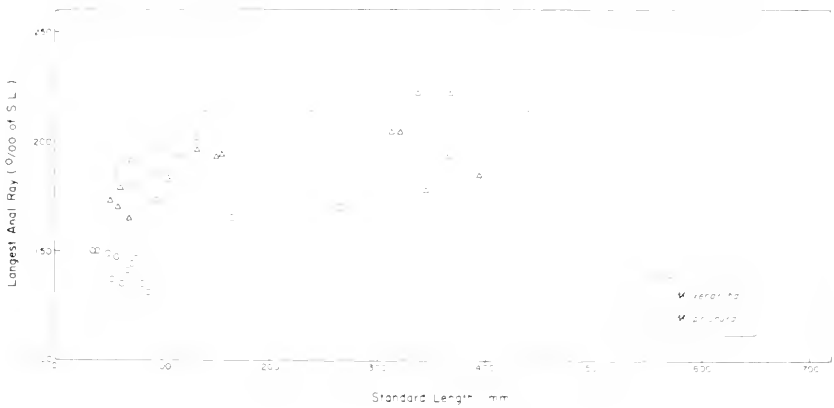

FIGURE 6—Length of longest anal ray expressed as thousandth of standard length vs. standard length in *M. xenarcha* and *M. prionura*.

Derivation of Name

From the Greek *prion* saw and *oura* tail.

Range

Known from Islas Santa Inez to Inner Gorda Bank, Baja California, Territorio del Sur, and from Bahía Banderas, Jalisco, Mexico.

Material Examined

Holotype: A 378-mm ripe female, SIO66-48, Mexico, Baja California Sur, Inner Gorda Bank (23° 02′ N, 109° 31′ W), 25–30 fathoms (45–54 m), hook and line, Susumo Kato and Karl P. Kuehnow on M/V *Red Rooster*, May 15, 1966.

Paratypes: Mexico, Gulf of California, Baja California—SIO65-260, 2(51–54); SIO65-270, 16(37–260); SIO65-283, 5(50–80); SIO65-287, 1(70); SIO65-290, 5(31–56); SIO65-295, 1(57); SIO65-301, 1(65); SIO65-306, 23(35–63); SIO65-309, 1(24); SIO65-311, 4(34–58); SIO65-312, 2(40–62); SIO65-317, 5(42–170); SIO65-319, 5(35–67); SIO65-322, 22(47–76); SIO65-325, 2(43–46); SIO65–329, 5(36–60); SIO65-345, 4(54–66); SIO65-347, 20(46–83); SIO65-351, 5(50–89); SIO65-354, 1(44). Mexico, Jalisco, Bahía Banderas—USNM 101061, 1(512).

Addendum

After this paper had been submitted for publication, another specimen of *M. prionura* was secured. Inasmuch as it is the largest known specimen of the species, data taken from it are presented here. Measurements in mm and proportions in thousandths are given in the same order as in Table 4.

SIO67-17, a 682-mm specimen taken by hook and line at Bahía San Lucas, Baja California, Mexico, sex undeterminable. D XI, 16; A III, 11; pectoral rays 16; gill rakers 35. Measurements, followed by proportions in parentheses: 253(290); 75.5(091); 119.5(174); 31.9(036); 60.0(068); 211(242); 191(219); 73(084); 139(159); 137(157); 102.5(118); 64.0(073); —; 65(074); 111(127); 102.5(118); 27.0(039).

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Carl L. Hubbs and John E. Fitch have supplied important information concerning the northern range limits of *Mycteroperca jordani* and *M. venarcha*. Giles W. Mead and Myvanwy Dick (Museum of Comparative Zoology, Harvard University), Ernest A. Lachner (U. S. National Museum), and Boyd W. Walker and Wayne J. Baldwin (Department of Zoology, University of California, Los Angeles) allowed us to examine important material at their respective institutions. Field work was supported in part by National Science Foundation Grant GB 4408.

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WILD TURKEY FOOD HABITS IN SAN LUIS OBISPO COUNTY, CALIFORNIA[1]

WALTON A. SMITH and BRUCE BROWNING
Wildlife Management Branch
California Department of Fish and Game

Fifty-nine wild turkeys (*Meleagris gallopavo*) were collected in 1966 to study food habits and to assist in the appraisal of suitable release sites for turkeys transplanted from wild stock. The staple food item was wild oats through the year, supplemented by green grass and forb leafage in the spring and acorns in the fall. The results indicate that much potential habitat is available in the 9 million acres of woodland-grass and woodland-chaparral habitat in California, and that the limiting factor for wild turkeys probably is not food. However, competition for food and deferred grazing should be considered in wild turkey management. Adult male turkeys are significantly larger and females slightly smaller than turkeys from other states, but a larger sample is necessary to substantiate this. Other body measurements fall well within the range of those from birds of other states.

INTRODUCTION

An estimated 5,000 wild turkeys are present in the oak woodland-grass habitats of San Luis Obispo and southern Monterey counties, located in south central coastal California. These birds originate from a series of game farm releases from 1932 to 1950, totaling 1,036 birds. These birds were reared and released by the California Department of Fish and Game. Burger (1954*a*) believes the birds released from the game farm were of hybrid origin from crosses between the domestic turkey and the Mexican turkey (*M. g. gallopavo*) and or the Merriam turkey (*M. g. merriami*).

Because of the success of the San Luis Obispo population, the area serves as a source of turkeys for transplanting to other suitable sites in the State. Between 1961 and 1966, 265 turkeys were trapped from this area and released in San Luis Obispo, Monterey, Santa Barbara, Shasta, Mendocino, and Trinity counties. The latter two releases were made by airplane, a relatively new and successful technique in turkey transplanting.

A collection of turkeys was made on a quarterly basis in 1966 to study their feeding habits and gather other biological data, and to assist in the intelligent appraisal of other suitable release sites within the State.

DESCRIPTION OF THE AREA

The turkeys were collected from the western slope of the Santa Lucia Range in San Luis Obispo County. This range, part of the South Coast Range, consists of rugged mountains virtually rising out of the ocean in the central and south portions of Monterey County, which give way

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to rolling foothills and less rugged mountain chains merging into coastal plain in San Luis Obispo County where the turkeys were collected.

Upper Sonoran chaparral vegetation predominates over most of the outer coastal ranges. Grass and woodland-grass types predominate where the coastline changes to rolling hills or coastal plain. Two main types of chaparral exist. Chamise (*Adenostema fasciculatum*) dominates one and coastal sagebrush (*Artemisia californica*) the other. Common plants in the chaparral cover types are California buckwheat (*Eriogonum fasciculatum*), coyote brush (*Baccharis pilularis*), toyon,[2] mountain mahogany (*Cercocarpus betuloides*), redberry (*Rhamnus crocea*), coffeeberry (*R. californicus*), poison oak, scrub oak (*Quercus dumosa*), and manzanita (*Arctostaphylos* spp.). Other chaparral types are dominated by the various wild lilacs such as blue blossom (*Ceanothus thyrsiflorus*), jim brush (*C. sorediatus*), and deer brush (*C. integerrimus*).

The dominant plant in the oak-woodland habitat is coast live oak (*Q. agrifolia*). Prevalent in the oak-woodland, but occurring mostly along the stream beds, are California bay, canyon live oak (*Q. chrysolepis*), big-leaf maple (*Acer macrophyllum*), and occasional native sycamores (*Platanus racemosa*).

The grassland is the California annual type, which consists of soft chess, wild oats and barleys, fescues (*Festuca* spp.), filarees, and bur clover. Solid stands of oatgrass (*Danthonia* sp.) and false brome grow locally in some of the grassland habitats.

The climate is characterized by a winter rainy season and a dry summer season, summer fog, little frost, and virtually no snowfall. Mean yearly rainfall is 22 inches in the San Luis Obispo area. Rainfall varies from year to year and is lowest along the coastline and heaviest towards the mountains. The mean annual temperature is about 57 F, and extreme temperatures are rare, because of the nearness of the ocean.

COLLECTION AND METHODS

Fifty-nine wild turkeys were collected during the study. Fifteen birds were taken in February, 16 in May, 14 in August, and 14 in November. Forty-four adult males, 9 adult females, 3 immature males, and 3 immature females were taken.

Crop contents were analyzed by standard food habits techniques. The frequency of occurrence was tallied and the quantity measured by water displacement in a graduated cylinder. The volumes were converted to percentages and summarized by the "aggregate percentage method" (Martin, Gensch, and Brown, 1946).

Sex of the birds was determined by the color of the breast feathers and by the presence of caruncles on the males. Age was determined by the shape of the two outer primaries and the shape of the tail (Keiser and Kozicky, 1943) and also by probing the bursa of Fabricius.

WEIGHTS AND MEASUREMENTS

The average weight of 44 adult male turkeys and 9 adult females was 18.4 and 9.2 pounds, respectively. The weights ranged from 13 to 24 pounds for the males and 8.5 to 11 pounds for the females (Table 1).

[2] Scientific names listed in Table 2 are omitted in the text.

For three juvenile males (6–8 mos. old) and three juvenile females (8–13 mos. old), the average weights were 12.5 and 9.1 pounds, respectively. The weights varied from 12.0 to 13.3 pounds for the males and 9.0 to 9.3 pounds for the females.

TABLE 1

Weights and Measurements of 59 Wild Turkeys

Sex and age (Sample size)	Weight* (Range)	Overall length†	Length of wing	Length of beard	Length of tarsus	Length of middle toe
Adult male 44	18.4 (13.0–24.0)	45.4 (42.0–47.8)	19.9 (18.8–21.3)	9.0 (4.3–11.8)	5.9 (5.3–6.7)	3.7 (3.4–4.1)
Adult female 9	9.2 (8.5–11.0)	37.6 (35.5–39.5)	16.1 (15.8–16.3)	--	5.1 (4.5–5.5)	3.1 (2.8–3.6)
Immature male 3	12.5 (12.0–13.3)	43.9 (43.0–44.8)	18.1 (17.8–18.6)	2.7 (1.1–2.8)	5.7 (one only)	3.7 (3.5–3.9)
Immature female 3	9.2 (9.0–9.3)	37.9 (37.0–39.3)	16.3 (16.0–16.5)	--	4.6 (4.5–4.8)	3.0 (2.8–3.1)

* Weights in pounds.
† Measurements in inches.

Jonas (1966) reported the average weights of Montana turkeys to be 15.9 and 10.3 pounds, respectively. Schorger (1966) summarized data from other states as follows: Arizona, 17.5 and 9.5 pounds for adult males and females, respectively; New Mexico, 13.8 and 10.0 pounds; Colorado, 16.5 and 10.1; Wyoming, 16.1 and 9.3. The California sample of adult males averaged significantly heavier than average adult male weights reported for the species, but the females averaged slightly lighter. A larger sample is necessary to substantiate this. It is probable that the hybrid origin of our stock is responsible for this difference. Seventeen of the 44 adult males from San Luis Obispo County weighed over 20 pounds.

The average weight of adult males sampled varied according to the season. The average weight of 11 collected during February 1966 was 20.1 pounds; 14 in May, 19.1 pounds; 9 in August, 16.3 pounds; and 10 in November, 17.5 pounds. Birds collected in February were heaviest, indicating favorable conditions through the winter.

Other measurements of the San Luis Obispo turkeys, including the overall length and length of wing, beard, tarsus, and middle toe (Table 1), fall well within the range measurements of birds found in other states as summarized by Schorger (1966). The measurements of the middle toe differed because the length of the claw was included.

FOOD HABITS

A number of references on the foods of eastern wild turkeys and on the Merriam race of the southwest are available. However, this is the first study of its kind in California, and only now is it possible because of the success of the introduction in the south central coast area.

Fifty-nine turkeys (one crop was empty) collected seasonally selected 64 food items (Table 2). Graphic presentation of the seasonal results of the more significant food items (Figure 1) shows very

TABLE 2

Food items Eaten by 58 Wild Turkeys, San Luis Obispo County

Item*	Feb. 1966		May 1966		Aug. 1966		Nov. 1966		Totals	
	Vol.% (14)	Freq.	Vol.% (16)	Freq.	Vol.% (14)	Freq.	Vol.% (14)	Freq.	Vol.% (58)	Freq.
Plant foods										
Wild oats, *Avena fatua, A. barbata*	6.5	6	55.4	16	69.1	14	21.6	11	38.8	47
Cultivated oats, *Avena sativa*	44.9	10	8.3	5	2.9	1	3.1	1	14.7	17
Oak acorns, *Quercus* spp.							48.1	12	11.6	12
Grass leafage, Gramineae	21.7	14	tr	1	tr	4	7.4	11	7.0	30
Cultivated barley, *Hordeum vulgare*	6.2	6	0.4	4	7.3	4	2.1	4	3.9	18
Italian ryegrass, *Lolium multiflorum*			7.6	7					2.1	7
Western thistle, *Cirsium occidentale*							8.0	7	1.9	7
Smooth cat's ear seeds, leaves, flowers, *Hypochoeris glabra*			3.0	7	1.1	1	2.4	2	1.7	10
Bluegrass, *Poa annua*	7.1	1	tr	2					1.7	3
Clover leafage, *Trifolium* sp.	6.3	12	0.2	1					1.6	13
Popcorn flower flowers, seeds, *Plagiobothrys nothofulvus*			5.2	8					1.4	8
Spear-leaved agoseris flowers, *Agoseris retrorsa*			5.0	1					1.4	1
California laurel fruit, seeds, *Umbellularia californica*			4.1	2			0.8	3	1.3	5
Poison oak seeds, stems, *Rhus diversiloba*	0.8	3			4.2	6	tr	4	1.2	13
Milk thistle, *Silybum marianum*					5.1	12			1.2	12
Toyon fruit, *Photinia arbutifolia*	1.8	1	2.5	2					1.1	3
Vetch, *Vicia* sp.	1.9	5	0.1	1	1.6	6	tr	3	0.9	15
Bristly ox-tongue leaves, flowers, *Picris echioides*					3.7	2			0.9	2
Pear fruit, *Pyrus* sp.					2.6	2			0.6	2
Buttercup leaves, seeds, *Ranunculus* sp.	0.5	4	0.5	12			tr	1	0.3	17
Quakinggrass, *Briza maxima*					1.1	4	0.3	2	0.3	6
Mariposa lily flowers, *Calochortus* sp.			1.2	2					0.3	2
Forb leafage	tr	6	tr	3			1.0	10	0.2	19
Red pimpernel seed capsules, *Anagallis arvensis*			0.2	4	0.4	2			0.2	6
Sedge, *Carex* sp.			0.9	4					0.2	4
Prickly lettuce stems, flowers, *Lactuca* sp.			0.2	2	0.6	1			0.2	3
Unidentified Compositae flowers, seeds			0.3	2	0.1	2			0.1	4
Prickly sow thistle seeds, flowers, *Sonchus asper*			0.2	4					0.1	4
Oxalis seeds, flowers, *Oxalis* sp.			0.4	2					0.1	2
Strawberry fruit, *Fragaria* sp.			0.3	2					0.1	2
White-stem filaree, *Erodium moschatum*	0.4	1							0.1	1
Insect galls	tr	5					0.1	6	tr	11
Bur clover, *Medicago hispida*	tr	1	tr	5			tr	4	tr	10
Canarygrass, *Phalaris minor*	tr	5					--	--	tr	5
Filaree seeds, leaves, stems, *Erodium* sp.	tr	4				--	tr	1	tr	5
Red-stem filaree leaves, *Erodium cicutarium*	tr	3		--	--	--	--	--	tr	3
Pine needles, *Pinus* sp.	tr	2	tr	1			--	--	tr	3
Soft chess, *Bromus mollis*	--		tr	2	--	--	tr	1	tr	3
Windmill pink, *Silene gallica*	tr	1	0.1	1	--	--	--	--	tr	2
False brome, *Brachypodium distachyon*			--	--	tr	2	--	--	tr	2
Beardgrass, *Polypogon monspeliensis*	--	--	--	--	--	--	tr	2	tr	2
Elegant microseris seeds, flowers, *Microseris elegans*	--		0.1	1	--	--	--	--	tr	1
Wild mustard, Cruciferae	tr	1	--	--	--	--	--	--	tr	1
Indian mustard flowers, *Brassica juncea*	--	--	tr	1	--	--	--	--	tr	1
Violet, *Viola* sp.	--	--	tr	1	--	--	--	--	tr	1
Small-flowered melica, *Melica imperfecta*	--	--	tr	1	--	--	--	--	tr	1
Gooseberry, *Ribes* sp.	--	--	--	--	--	--	tr	1	tr	1
Wild barley, *Hordeum* sp.	--	--	--	--	--	--	tr	1	tr	1
Tarweed, *Madia* sp.	--	--	--	--	--	--	tr	1	tr	1
Common dandelion, *Taraxacum officinale*	--	--	--	--	--	--	tr	1	tr	1
Juniper stems, *Juniperus* sp.	--	--	--	--	--	--	tr	1	tr	1
Ceanothus, *Ceanothus* sp.	--	--	--	--	--	--	tr	1	tr	1
Mint family, Labiatae	--	--	--	--	--	--	tr	1	tr	1
Animal foods										
Insect fragments, Insecta	1.8	6	2.4	12	0.2	3	2.6	4	1.7	25
Jerusalem cricket, *Stenopelmatus longispina*	--	--	0.3	1	--	--	1.6	5	0.5	6
Isopod, Isopoda	--	--	1.0	4	--	--	--	--	0.3	4
Spider fragments, Arachnida	--	--	0.1	4	--	--	tr	1	0.1	5
Grasshopper fragments, Locustidae	--	--	--	--	--	--	0.6	2	0.1	2
Scarab beetle, Scarabaeidae	--	--	--	--	--	--	0.3	1	0.1	1
Crustacean fragments, Crustacea	0.1	1	--	--	--	--	--	--	tr	1
Snail, Gastropoda	--	--	tr	1	--	--	--	--	tr	1
Tapeworm fragments	--	--	tr	1	--	--	--	--	tr	1
Beetle, Coleoptera	--	--	--	--	--	--	tr	1	tr	1
Pupa case	--	--	--	--	--	--	tr	1	tr	1
Insect larva, Elateridae	--	--	--	--	--	--	tr	1	tr	1

* All items are seeds unless designated otherwise.

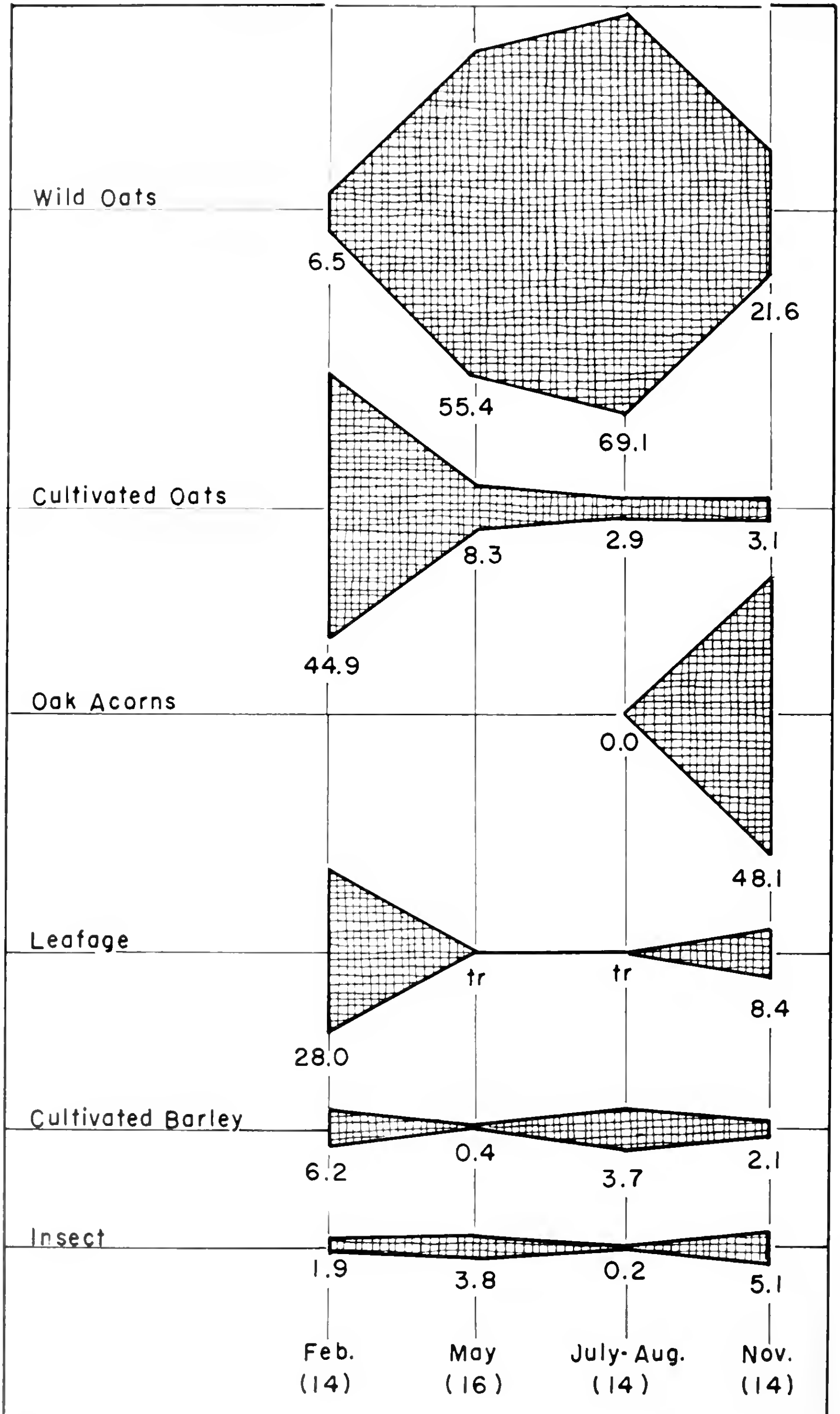

FIGURE 1—Seasonal use by turkeys of the principal food items, expressed in volume percentage. Drawing by [illegible]

clearly a seasonal pattern similar to that exhibited by turkeys from studies in Florida (Schemnitz, 1956), Missouri (Dalke, Clark, and Korschgen, 1942), and New Mexico (Ligon, 1946), for example. Grass seeds, principally wild oats and barley, constituted the staple food through the year, supplemented by green grass and forb leafage in the late fall and early spring, and by oak mast in the fall. The spring use of green grass is characteristic of all gallinaceous birds.

Wild oat seeds comprised over a third of all of the food eaten by 58 turkeys sampled and occurred in 81% of the crops. Amounts ranged from over half in May to over two-thirds in August.

On the south coast wild oats generally produce a good crop each year. During 1966, a "bumper crop" of wild oats was produced (Gene Gerdes, pers. commun., 1967). Hence, wild oats were a readily available food source. Turkeys are able to reap the seeds from the plant by cleaning the rachis with an upward stripping stroke. One crop contained 2,880 wild oats weighing 65 g.

Supplemental cattle feeding influenced the February food habits of the turkeys. Cultivated oat and barley hay is distributed in fields to cattle to assist in holding them through the winter. The turkeys at this time commonly are found in such fields working the scattered hay; hence the cultivated oats and barley in the diet. Some barley and oats show up in the summer and fall foods, probably as a result of availability at the time of harvest. Turkey use of grain is common knowledge to wildlife managers in the east and southwest. Grain "food patches" and platform feeders are a common management technique for furnishing the wild birds emergency winter rations (Spicer, 1959; Dalke, Leopold, and Spencer, 1946; Ligon, 1946; Schorger, 1966).

Acorns appear in the fall diet (Figure 1). Oak mast, principally coast live oak acorns, made up almost half (48.1%) of the November food and occurred in 12 of 14 crops collected.

Coast live oak is characteristic of the south central coastal vegetation. It occurs in many of the cover types and is characteristic on low hills and in open valleys, on slopes of the higher foothills, and in shallow canyons.

The grass family is an important food source for the wild turkey throughout most of its range. Grass leafage is a significant part of the diet from the time the range "greens up" in the fall on through the winter. Wild oats, cultivated grains, bluegrass, Italian ryegrass, and quakinggrass are also eaten. One wonders why soft chess, the most common plant of the California annual type of vegetation in the area, as well as false brome and oatgrass, which are abundant locally, were not found in quantity in the crops, since availability very often determines what is eaten.

Clover and other forb leafage supplement the green diet. It is probable that green feed supplies the necessary nutrition to make reproduction successful for gallinaceous birds. Grass and forb leafage combined to make 28% of the food eaten in the February sample and 8% of the fall diet.

A puzzle in this study is the low consumption of animal matter. Insects, particularly grasshoppers, usually are important spring and summer turkey foods (Burger, 1954*b*; Schemnitz, 1956; Ligon, 1946).

Animal foods constituted only 2.8% of the food eaten, and grasshoppers made up less than 1% during just 1 month (November) of the collection and occurred in only 2 out of 58 stomachs. However, availability is probably the reason again. San Luis Obispo County is not known for heavy infestations of grasshoppers, and populations of this insect in California have been at a low ebb since 1962 because of a lethal fungus (Ronald Hawthorne, pers. commun., 1967).

MANAGEMENT IMPLICATIONS

Wild oats were the staple item of diet of the turkeys collected during 1966. Wild oats are an important exotic plant species of the "California annual type", described by Heady (1956), which replaced our native perennial grasses in the early development of the State. The principal components are soft chess, ripgut (*Bromus rigidus*), the wild oats and barleys, and the filarees. This annual type is found throughout the Sacramento and San Joaquin valleys and coastal ranges and valleys and is a principal component of the woodland-grass and woodland-chaparral habitat types, which makes up almost 9 million acres in California (California Department Fish and Game, 1965).

Throughout most of the wild turkey range in the United States, mast principally in the form of oak acorns and pine and other nuts, is considered one of the most important, if not the most critical, foods. Uhlig and Bailey (1952) were able to correlate kill figures with mast production, and Ligon (1946) pointed out that the range of the Merriam race of wild turkey actually coincides rather closely with that of the Gambel oak and pinyon pine.

The characteristic fall use of oak mast is documented by the results of this study. The dominant trees in the woodland-grass and woodland-chaparral habitats are oaks. Therefore, projecting the use of wild oats and oak mast for the 9 million acres of this habitat, of which oats and oak are an integral part, it would seem that there is an abundance of potential turkey habitat with suitable foods throughout California. The limiting factor in successful introduction of wild turkeys would therefore be something other than an inadequate food supply.

Deferred grazing could become important in turkey management. Cattle, as well as other animals and birds, compete for the annual grasses. Ligon (1946) and Spicer (1959) both mention heavy stock grazing as detrimental to turkey habitat. Seed producing grasses are not able to mature or stay in sufficient quantities to support a population of turkeys. Spicer (1959) documents that an area under heavy grazing wintered only 12 turkeys. When closed to grazing by domestic livestock, 84 turkeys wintered in the same area. Deferred grazing practices, which encourage wild oats and the other important species of the California annual type (Heady, 1956) might solve this dilemma. Competition with other animals is a factor to be considered in selecting transplant sites for wild turkeys.

These food habits data point out the possibility of conflict with agriculture. Turkeys will take cultivated grains, although most of the grain from this San Luis Obispo sample was waste grain. However, as Dalke et al. (1942) mention, when mast crops fail turkeys are liable to move out of the oaks into the fields in search of winter foods. While California's winters are not as severe as winters in the east, mast crops are just as undependable. Hence, the possibility of conflict with agricultural interests will have to be considered when selecting prospective turkey habitat.

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WHITE CATFISH (*ICTALURUS CATUS*) OF THE SACRAMENTO-SAN JOAQUIN DELTA[1]

DAVID P. BORGESON[2] and GEORGE W. McCAMMON[3]
Inland Fisheries Branch
California Department of Fish and Game

The biology and vital statistics of white catfish in the Sacramento-San Joaquin Delta were investigated during the period 1952–55. Amphipods (*Corophium* spp.) were the most important food of catfish in the lower Delta. The seventh vertebra was used to determine age. Growth was calculated from the vertebral — fish length relationship $L = 0.76760 + 0.056651R - 0.000051R^2$. Mean fork lengths at each year of life were: Age I – 3.1 inches; Age II – 5.2 inches; Age III – 6.9 inches; Age IV – 8.4 inches; Age V – 9.9 inches; Age VI – 11.5 inches; Age VII – 12.9 inches; Age VIII—13.8 inches. Spawning commenced when water temperatures reached 70 F in June and continued into July. About 50% of fish in the 6.5- to 7.4-inch group were mature. Almost all fish over 9 inches were mature. Tagging studies provided estimates of survival and mortality rates for partially vulnerable and fully vulnerable segments of the population. Completely vulnerable fish (over 8.5 inchtes FL) exhibited a total annual mortaiity of 57%. Mortality due to fishing was 33%.

White catfish support a substantial sport fishery in the Sacramento-San Joaquin Delta. Before September 1953, they also supported a commercial fishery (Warner, 1949). This was abolished when the catfish population showed signs of overfishing (Pelgen, 1952).

This is the third and final report on a study to obtain background information needed for effective management of the Delta catfish resource. Pelgen (1954) and Pelgen and McCammon (1955) described tagging methods and reported early findings. This paper presents later findings on movements, diet, mortality, reproduction, and growth rates.

METHODS

Between January 15 and May 22, 1952, 2,865 catfish were tagged with opercular strap tags and released in essentially equal numbers at six sites (Antioch Bridge, Old River, Burns Cutoff, Sandmound Slough, Sutter Slough, and the Sacramento River 6 miles above Sacramento). Concurrently, 601 catfish bearing disk-dangler tags were released in nearly equal numbers at five of these sites (all but Sandmound Slough).

Between December 16, 1952, and January 27, 1953, 1,499 tagged catfish were released: 499 at Antioch Bridge, 500 at Disappointment Slough, and 500 at Cache Slough. At each site, 250 staple-tagged fish were released. The rest were tagged with disk-danglers, which are very similar to the staple tag (Pelgen and McCammon, 1955).

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[2] Now with Michigan Department of Conservation, Lansing, Michigan.
[3] Now with Water Projects Branch, California Department of Fish and Game.

Between January 25 and April 15, 1954, 500 catfish were released at each of four sites: the last three mentioned plus Old River. Only disk-dangler tags were used.

Fish were caught with typical commercial fyke (hoop) nets. Only healthy-appearing individuals were tagged, without selection for size. Figure 1 shows their length frequencies. All measurements, here and elsewhere, are fork lengths.

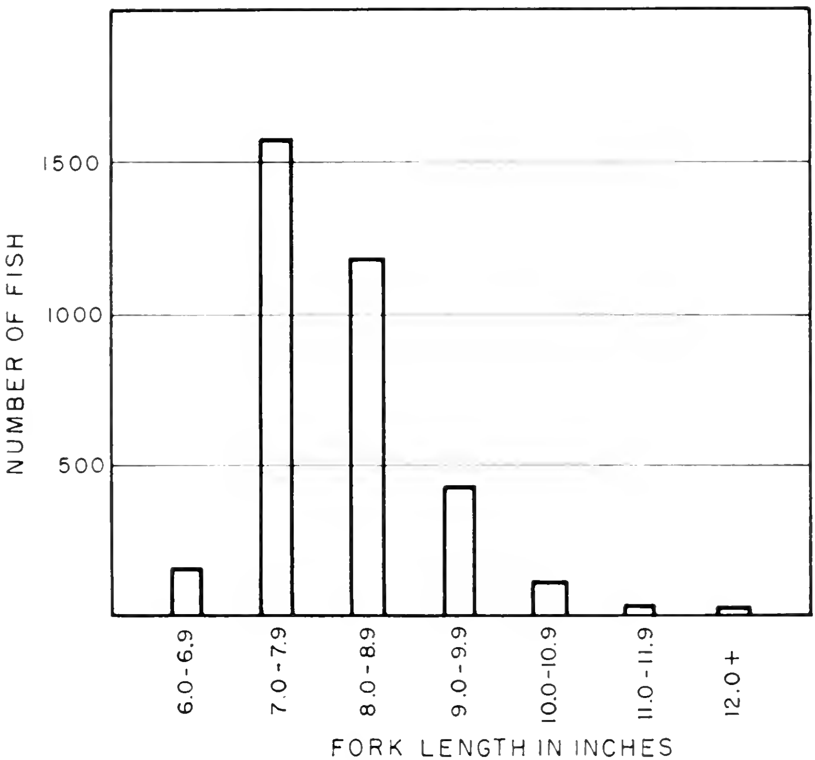

FIGURE 1—Length-frequency histogram of white catfish tagged in second and third Delta catfish studies.

The three separate tagging periods and their results were called the first, second, and third Delta catfish studies. The work was publicized by press releases, posters, prize drawings, and personal contact to encourage return of tags.

RESULTS AND DISCUSSION

Tag Suitability

In the first study, a sixfold greater return was realized from disk-dangler tags than from opercular strap tags because the latter exhibited an appreciable shedding rate. Strap tags also became covered rapidly by a layer of opaque mucus and probably went unnoticed by fishermen (Pelgen, 1954; Pelgen and McCammon, 1955).

In the second study, returns from disk-dangler tags exceeded those from staple tags by a substantial margin (278 to 220). This is surprising in view of the similarity of the tags and the results obtained in the study of Clear Lake catfish (McCammon and Seeley, 1961), in which staple tag returns slightly exceeded disk-dangler returns.

The difference in returns in the Delta most probably resulted from some type A systematic error in return of staple tags. There is strong evidence that commercial fishermen failed to return a large number of tags during the last half of December 1952 and January through April 1953 (Pelgen and McCammon, 1955). However, what part this nonreturn or other factors may have played in the difference in returns can not be demonstrated. We believe that both staple and disk-dangler tags are suitable for white catfish.

Migration from Tagging Sites

Movement patterns varied somewhat among tagging sites. Fish released at Sutter Slough, Burns Cut, and the Sacramento River near Sacramento were typically recaptured considerable distances upstream (Figure 2). Some of the fish released at Antioch Bridge and Cache Slough exhibited marked upstream movement but most recaptures were within about 5 miles of the tagging site. Fish released at Disappointment Slough and Old River showed the least tendency to leave the tagging area. Fish from these two sites and, to a lesser degree, those from the Antioch Bridge and Cache Slough sites dispersed rapidly after their release to all parts of what appear to be their home ranges. Tag return patterns suggest that home ranges delineated by 6- to 12-month returns were not appreciably extended by 3- to 8-year returns. The factors responsible for the observed movements are not clear.

Diet

In all, 121 stomachs containing food were collected near Antioch Bridge during 1953 and 1954. All months except December, January, February, and April were sampled. On June 24, 1954, 29 more stomachs containing food were collected from the Sacramento River at Fremont Weir (about 15 miles above Sacramento). Contents were analyzed to obtain percentage volume composition.

This limited sampling gave some insight into catfish diets. In the lower Delta, *Corophium* spp. (amphipods) were an important food throughout the year. The Fremont Weir collection coincided with the American shad (*Alosa sapidissima*) run and shad parts (probably torn from dead shad) were conspicuous in the diet. Unidentified animal and plant debris formed about half of the stomach contents from both areas. Other items eaten were unidentified fishes, insects, and clams, crayfish (*Pacifastacus* sp.), and mysid shrimp (*Neomysis mercedis*).

Growth

Pectoral spines were unsuitable for age determinations. The first and second annuli are often obliterated by bone deterioration around the

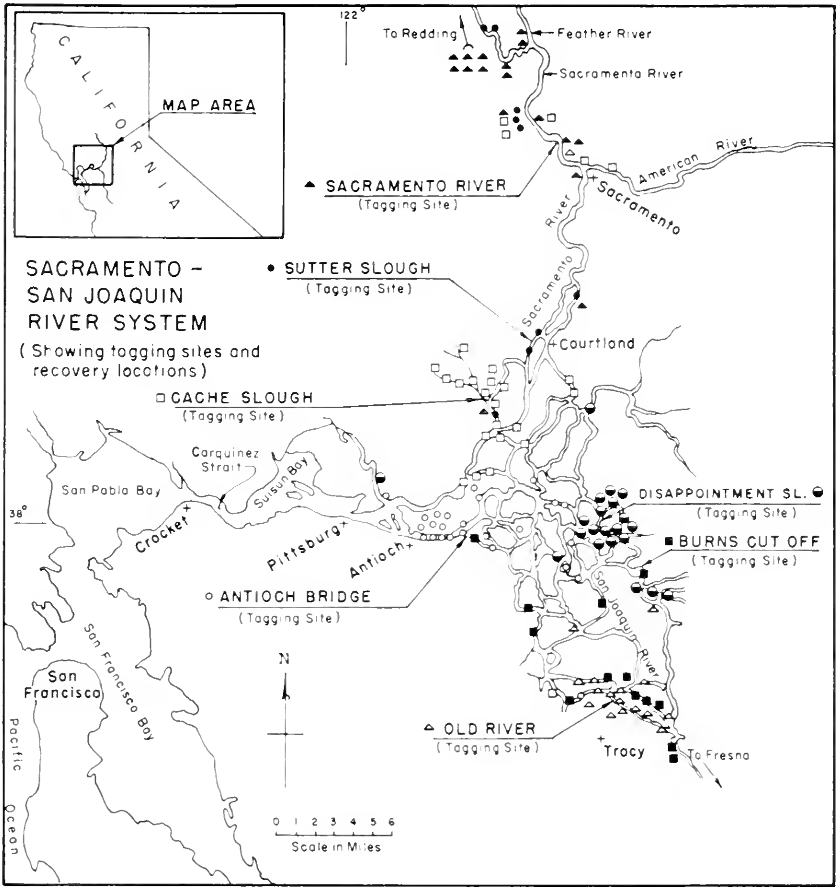

FIGURE 2—Map of Sacramento-San Joaquin Delta, showing tagging sites and points of recapture. Returns plotted were at liberty at least 6 months.

lumen. Moreover, as the lumen increases in diameter, its center shifts, distorting calculations. These problems were avoided by using the seventh spinal vertebra. At the time of the study, this method had not been recorded for white catfish.

Fish length plotted against dorsal vertebral radius (measured on the anterior face of the vertebra with an ocular micrometer set in a standard dissecting microscope) gave a curvilinear relation:

$$L = 0.76760 + 0.056651R - 0.000051R^2$$

L = fork length in inches

R = vertebral radius in millimeters $\times$ 0.22

This curve (Figure 3) fits empirical data well (correlation coefficient = 0.972).

Samples taken in 1954 and 1955 from the Sacramento River at Fremont Weir were used for age and growth determinations (Table 1) and for calculating the length-weight relationship (Figure 4). Devi-

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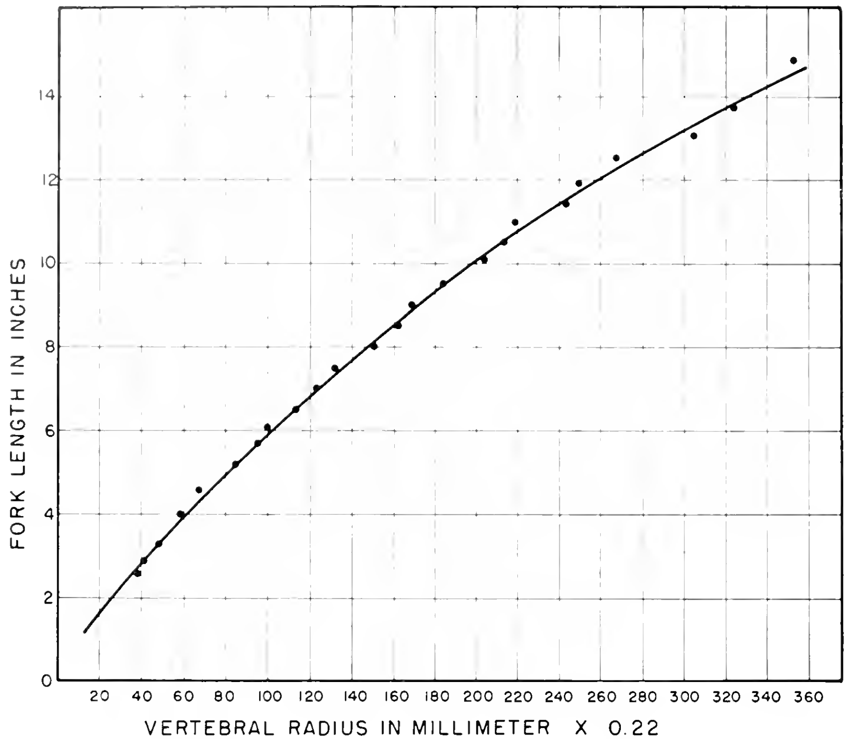

FIGURE 3—Body length-vertebral radius relationship for white catfish collected at Fremont Weir, Sacramento River, in October 1954 and 1955.

ations in mean annual growth were in close agreement for both samples, thus substantiating the validity of the vertebral method of aging white catfish (Table 2).

TABLE 1

Age and Growth of White Catfish Collected in October, 1954 and 1955, at Fremont Weir Near Sacramento

Age group	Number of fish	Mean fork length when caught (inches)	Mean fork length at end of each year of life (inches)							
			1	2	3	4	5	6	7	8
I	6	6.1	3.7							
II	124	6.9	3.1	5.3						
III	195	8.1	3.0	5.1	6.8					
IV	91	9.5	3.0	5.2	6.9	8.3				
V	38	10.6	3.1	5.2	6.9	8.4	9.7			
VI	4	12.4	3.4	6.0	7.2	8.8	10.2	11.3		
VII	3	13.6	3.5	6.1	8.1	9.7	10.9	11.9	12.9	
VIII	2	15.2	3.3	5.8	7.8	9.7	10.8	12.1	13.0	13.8
Average calculated length (inches)			3.1	5.2	6.9	8.4	9.9	11.5	12.9	13.8
Average annual increment (inches)			3.1	2.1	1.7	1.5	1.5	1.6	1.4	0.9
Number of fish			463	457	333	138	47	9	5	2

TABLE 2

Percentage Deviation From Mean Annual Growth Increment of White Catfish in the Sacramento River

Year of collection	Calendar year								
	1946	1947	1948	1949	1950	1951	1952	1953	1954
1954	+3.4	+14.5	−1.2	+14.6	−7.5	−10.7	−7.7	−2.1	--
1955	--	+3.3	+6.4	+20.6	+1.1	−18.7	−9.6	−5.8	+1.9

Fork length at annulus formation was calculated from the vertebral radius to each annulus, using Figure 3.

Delta white catfish grow appreciably slower during the first three years of life than those in the Patuxent River, Maryland (Schwartz and Jachowski, 1965).

Spawning Time, Size at Maturity, and Fecundity

Periodically during June and July of 1953 and 1954, the gonads of 762 white catfish caught in the Antioch Bridge area with fyke nets were examined. During 1953, between June 8 and 23, when water temperatures reached 64 to 66 F, no spent fish were observed. On July 1, when water temperatures ranged from 66 to 71 F, 17 of 32 mature females were spent or partially spent. On July 21, 16 of 20 mature females were spent (water temperature 72 F).

On July 25, 1954, 9 of 27 mature females were spent (water temperature 70 F) and by July 29 (water temperature 77 F) all 138 fish observed were spent.

Thus, spawning in the Antioch Bridge area apparently commences in late June, when water temperatures reach about 70 F, and continues well into July.

There was no difference in size at maturity between male and female catfish. About 10% of 6.0- to 6.4-inch fish were mature, compared with 40% of the 6.5- to 6.9-inch group, 60% of the 7.0- to 7.4-inch group, 85% of the 7.5- to 7.9-inch group, 90–95% of the 8.0- to 8.9-inch group, and nearly 100% of individuals over 9 inches.

The relationship between body weight and egg production was linear within the common size range of white catfish in the Delta (100 to 600 grams)—about 600 eggs per 100 grams body weight.

Vulnerability

The vulnerability of white catfish in the Delta increases with size. Average first-year returns (expressed as a percentage of those tagged) from three size groups tagged during the second and third studies were: from fish less than 7.5 inches long—9.2%; 7.5 to 8.4 inches—14.6%; 8.5 inches and larger—21.1% (Table 3). Catfish 8.5 inches and larger are fully vulnerable to the sport fishery (see following section).

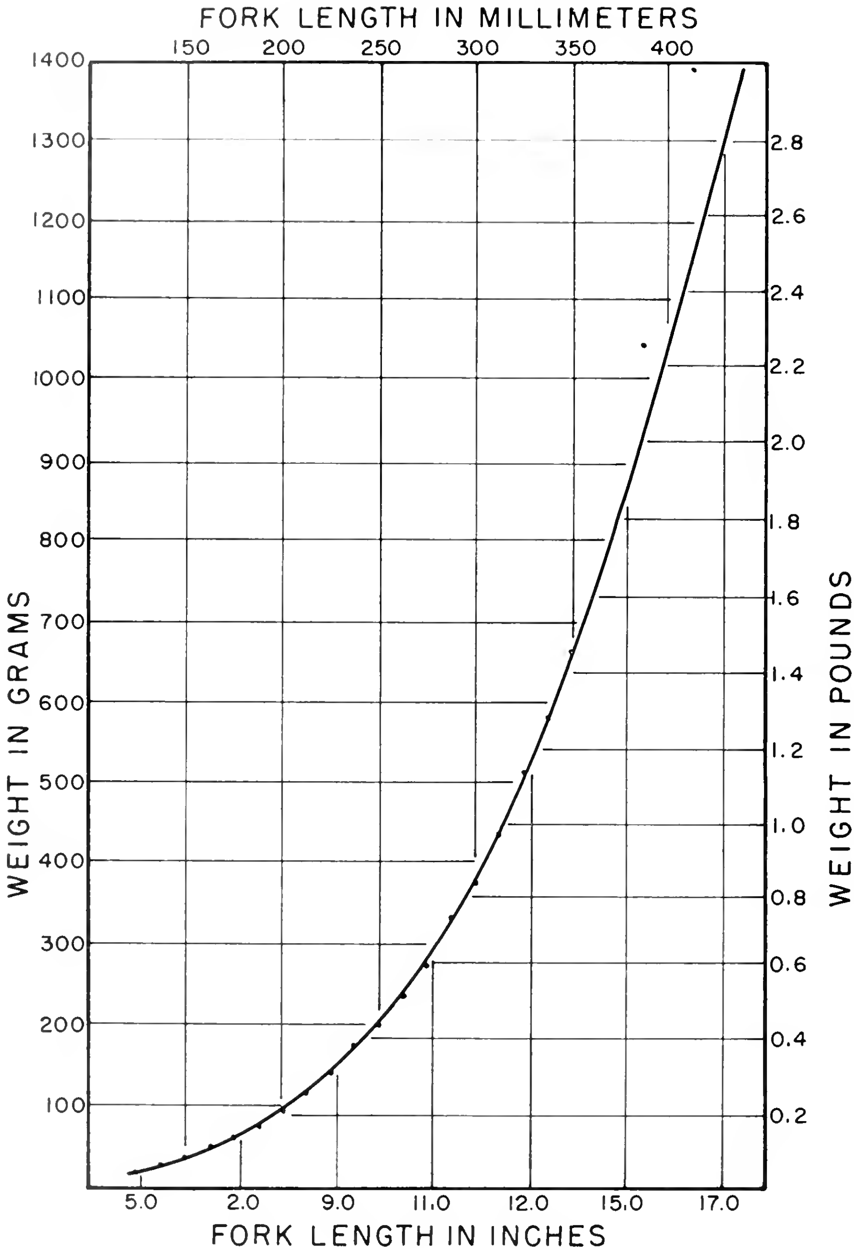

FIGURE 4—Graph of length-weight equation (Log L (millimeters) = —5.65374 + 3.33063W (grams)) for 443 white catfish collected at Fremont Weir, Sacramento River, in October 1953. Dots represent empirical data.

TABLE 3
Angler Returns of White Catfish by Size Group
Second and Third Delta Catfish Studies

Size group (inches)	6.5-7.4	7.5-8.4	8.5 and larger
Number tagged	913	1,590	985
Returns			
1st year	84 (9.2%)	232 (14.6%)	208 (21.1%)
2nd year	67	148	75
3rd year	48	70	37
4th year	36	41	14
5th year	22	20	7
6th year	5	10	4
7th year or over	2	1	1
Totals	264 (28.9%)	522 (32.8%)	346 (35.1%)

Mortality

Calculations of mortality and survival were based on the combined data from the second and third studies, for which three and four tagging sites, respectively, were used.

Increasing vulnerability with size complicated the calculation and expression of mortality and survival rates. Age and growth data suggest that it is reasonable to assign Age II+ to the 6.5- to 7.4-inch size group, Age III+ to the 7.5- to 8.4-inch group, and Age IV+ or older to fish 8.5 inches or longer at the time of tagging (most fish were tagged in the winter). It was also assumed that fish in the lower two size groups entered the next higher size groups in one year.

These assumptions allowed adjustments for differential vulnerability. Data from the second and third studies (Table 3) were used for survival (*s*) calculations based roughly on a calendar year (data from the first study were not comparable because of the more pronounced effects of the commercial fishery). Survival from Age II+ to III+ was obtained by dividing the number of catfish available at Age III+ by those available at II+ (which is 913, the number of 6.5- to 7.4-inch fish tagged). The number available at Age III+ was computed by dividing second-year returns from 6.5- to 7.4-inch fish (67) by the fraction of 7.5- to 8.4-inch fish caught their first year (0.146). Thus:

$$^{s}\text{II+} - \text{III+} = \frac{67/0.146}{913} = 0.50.$$

Using the same approach:

$$^{s}\text{III+} - \text{IV+} = \frac{148/0.211}{1{,}590} = 0.44.$$

Second- through sixth-year returns from 7.5- to 8.4-inch fish and returns from 8.5-inch and larger fish indicate that annual survival stabilizes after fish reach 8.5 inches (Age IV+). Therefore, mean annual survival after Age IV+ was obtained using the formula:

$$S = \frac{R_2 + R_3 \; . \; . \; . \; + R_n}{R_1 + R_2 \; . \; . \; . \; + R_{n-1}} \; :$$

$$^{\bar{s}}\text{IV+} \; . \; . \; . \; = \frac{70 + 41 + 20 + 10 + 75 + 37 + 14 + 7}{148 + 70 + 41 + 20 + 208 + 75 + 37 + 14} = 0.43.$$

Annual mortalities that complement these survival estimates are: Age II+ to III+, 0.50; Age III+ to IV+, 0.56; and Age IV+ on, 0.57. In order to partition this annual mortality, a, into that due to fishing, u, and natural causes, v, some measure or estimate of nonresponse (tags recaptured, but not reported) was needed. H. K. Chadwick (unpublished data), working with striped bass in the Delta, found that about 63% of nonreward tags were returned (assuming 100% return from $5 reward tags). Rawstron (1957, p. 46), working with white catfish in Folsom Lake (about 50 miles east of the Delta), calculated a 2-year mean nonresponse factor of 46%. Guided by these studies, we assumed a 60% response from Delta catfish anglers.

For Age IV+ and older fish, then,

$$u_{IV+} \ldots = \frac{0.351}{0.60} \times 0.57 = 0.33,$$

and

$$v_{IV+} \ldots = 0.57 - 0.33 = 0.24,$$

similarly,

$$u_{III+ - IV+} = \frac{0.146}{0.60} = 0.24,$$

$$v_{III+ - IV+} = 0.56 - 0.24 = 0.32,$$

$$u_{II+ - III+} = \frac{0.092}{0.60} = 0.15,$$

$$v_{II+ - III+} = 0.50 = 0.15 = 0.35.$$

The results of the above calculations are presented in Table 4.

TABLE 4

Mortality and Survival of Delta White Catfish

Age		a	u	v
II+–III+	0.50	0.50	0.15	0.35
III+–IV+	0.44	0.56	0.24	0.32
IV+	0.43	0.57	0.33	0.24

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George W. McCammon and David E. Pelgen planned the study and, with the help of Vincent Catania, Leonard Fisk, and other Department employees, carried out the field and laboratory work. The data were analyzed by David P. Borgeson and McCammon. Borgeson wrote the final report. H. K. Chadwick critically reviewed the manuscript. Cliffa E. Corson prepared the figures. Prize drawings, sponsored by the Foothill Sportmen's Club of Oakland, stimulated interest in the program and are gratefully acknowledged.

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STUDIES ON MONOGENETIC TREMATODES XXXVI. GYRODACTYLID PARASITES OF IMPORTANCE TO CALIFORNIA FISHES[1]

JOHN D. MIZELLE and DELANE C. KRITSKY
Sacramento State College, Sacramento, California

Ten new species of *Gyrodactylus* are described as follows: *G. ackerti* from *Platichthys stellatus* (Pallas), *G. alexanderi* from *Gasterosteus aculeatus* Linnaeus, *G. corti* from *Anarrhichthys ocellatus* Ayres, *G. cyprinodontis* from *Cyprinodon n. nevadensis* Eigenmann and Eigenmann, *G. imperialis* from *Gillichthys mirabilis* Cooper, *G. mirabilis* from *Cottus asper* Richardson, *G. nevadensis* from *Cyprinodon n. nevadensis*, *G. branchius* from *Platichthys stellatus*, *G. saratogensis* from *Cyprinodon n. nevadenis*, and *G. olsoni* from *Gillichthys mirabilis*.

Epizootics of gyrodactylids in North American fish hatcheries were reported as early as 1899 (Craig Brook Station, Maine) in the report of the U. S. Commissioner of Fish and Fisheries for that year. In 1901, Atkins identified the causative organism in that instance to be *Gyrodactylus elegans* von Nordmann. Pratt (1919) discovered a serious infection of *Gyrodactylus* sp. on the gills of rainbow trout (*Salmo gairdnerii*) in the New York state hatchery at Cold Spring Harbor, Long Island. In this case, the gills of practically all fish more than one year old were infected and in many cases the severity of the pathology was indicated by shriveled and functionless gills. Similarly, Van Cleave (1921) described and reported *Gyrodactylus fairporti* to be responsible for mortality in black bullheads, *Ictalurus melas* (Rafinesque), at the Fairport Biological Station of the U. S. Bureau of Fisheries, Fairport, Iowa. Although as far as known gyrodactylids rarely cause trouble in nature, it is readily understandable that under crowded hatchery conditions they may increase to dangerous proportions, since they are viviparous (live bearers) and are capable of rapid reproduction. This is compounded by the fact that adults of some species may harbor a total of three consecutive generations of larvae; e.g., *G. mirabilis* sp. n. and *G. vancleavei* Mizelle and Kritsky (1967*b*). The occurrence of definite species of *Gyrodactylus* and a record of the hosts involved are thought to constitute valuable information for consideration in cases of undetermined fish mortality.

The fish hosts and the parasites in the following descriptions were treated with reference to preparation, observation, measurement, illustration, and description including development and nomenclature, as given by Mizelle and Kritsky (1967*a*) and Kritsky and Mizelle (in press). An amended generic diagnosis of *Gyrodactylus* by Mizelle and Kritsky (1967*a*), which includes comprehensive morphology common to the group, justifies much shorter descriptions of new species in this genus. Therefore, it is understood that each of the following descrip-

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tions is preceded by "with characters of the genus as emended" by these authors. The shape given for the pharyngeal bulbs is that as viewed from the dorsal surface. Paratypes are in the authors' collections. Holotype numbers and measurements for each species are given in Table 1. The species described herein differ from their nearest relative in the morphology of the cirrus and haptoral armament (which see).

GYRODACTYLUS ACKERTI SP. N.

This species is based on nine specimens from gills of the starry flounder, *Platichthys stellatus* (Pallas), from Bodega Bay, Sonoma County, California.

Golden-brown granules frequently present in trunk parenchyma. Head organs conspicuous; cephalic lobes poorly developed or absent, inconspicuous spicule in each (or area). Pharyngeal bulbs subcircular, anterior smaller with conspicuous orifice; gut normal. Peduncle broad, haptor subcircular to ovate; hook arrangement intra- or extrahamular. Anchor bases perforate, folded mesiad to maximum of 180°; anchor shafts hollow; anchor filament crosses arc of anchor point, extends toward tip (Figure 1, item 3). Enlarged superficial-bar ends not covered by anchor folds in mounted specimens; bar shield wide, subtruncate (Figure 1, item 4). Deep bar transparent, attenuated ends well secured in anchor knobs (Figure 1, item 5). Proximal end of hook shanks slightly or not enlarged; hooklet with straight or slightly convex basal border, long recurved point, reduced heel, toe with shelf and transversely truncate end. FH loop extends 0.5–0.6 shank length, terminates on hooklet base or proximal shaft (Figure 1, item 1). Two embryos present in one specimen, one each in others. Cirrus in five specimens, with 6–8 subequal spinelets; one cirrus degenerate with spine and fragment of one spinelet. Sequential development of haptoral armament and temporal development of secondary embryo normal.

The nearest relative of this species is *Gyrodactylus branchius* sp. n.

GYRODACTYLUS ALEXANDERI SP. N.

This species is described from 19 specimens from skin of the threespine stickleback, *Gasterosteus aculeatus* Linnaeus, from Stow Lake (San Francisco), San Francisco County, California.

Cuticle usually striated transversely in midregion. Cephalic lobes moderate to conspicuous, large spicule each. Pharyngeal bulbs ovate, subequal; gut normal, crura often with diverticula and refractile granules. Peduncle moderate to broad, sharply constricted at subovate haptor. Anchor bases of moderate length, folds secure rami of superficial bar; anchor filament *may* cross anchor-point arc and extend to tip (Figure 1, item 3). Superficial-bar shield broadly rounded posteriorly, chromophilic areas extend into bar (Figure 1, item 4). Deep bar irreglar with median notch, ends well secured in anchor knobs (Figure 1, item 5). Hook arrangement extrahamular. Proximal end of hook shanks slightly or not enlarged, shank ligament conspicuous. Basal border of hooklet toe concave, shelf incipient, tip depressed; hooklet heel slightly globose, point with obtuse proximal bend and short recurved tip. FH loop heavy, extends 0.35 or less shank length, terminates near hooklet

TABLE 1

Measurements and USNM Helminthological Collection Numbers of *Gyrodactylus* spp.

	L	W	HL	HW	Ph	C	AL	ABW	SBL	DBL	HoL	HkL	USNM Nos.
G. ackerti	369 (339-432)	97 (86-112)	72 (59-86)	76 (55-87)	32 (26-37)	12 (10-13)	50 (45-62)	14 (10-15)	34 (31-35)	19 (18-20)	25 (24-27)	(6-7)	62047
G. alexanderi	698 (598-841)	128 (97-204)	101 (81-130)	131 (98-151)	63 (57-71)	20	79 (72-82)	15 (12-19)	40 (37-44)	18 (14-27)	43 (42-44)	11 (10-12)	62048
G. branchius	411 (372-452)	104 (96-109)	71 (64-80)	74 (64-92)	31 (29-34)	(14-15)	36 (35-37)	-- (8-9)	24 (22-25)	16 --	-- (29-30)	-- (6-7)	62049
G. corti	327 (229-457)	81 (72-85)	77 (63-86)	80 (63-101)	23 (22-24)	17 (16-19)	34 (32-35)	9 (8-11)	20 (19-24)	12 (9-15)	22 (21-23)	(5-6)	62050
G. cyprinodontis	353 (322-407)	72 (53-85)	67 (60-73)	70 (58-84)	23 (20-25)	12 (11-13)	49 (45-50)	12 (10-13)	23 (21-25)	15 (12-17)	24 (22-25)	-- (6-7)	62051
G. imperialis	365 (346-390)	79 (75-83)	64 (54-74)	68 (59-74)	26 (22-29)	-- (10-11)	40 (37-41)	-- (7-8)	23 (22-24)	14 (13-15)	22 (21-23)	5 --	62952
G. mirabilis	608 (540-723)	143 (84-204)	105 (87-127)	129 (115-153)	61 (46-71)	15 (13-17)	86 (82-92)	16 (14-17)	39 --	22 (20-23)	44 (43-45)	-- (9-10)	62953
G. nevadensis	400 (326-447)	74 (61-90)	52 (49-55)	57 (55-59)	21 (20-23)	11 --	33 (32-34)	8 (7-9)	-- (25-26)	-- (12-13)	17 (16-18)	5 --	62954
G. olsoni	371 (321-464)	97 (71-146)	63 (57-72)	65 (58-70)	31 (25-41)	-- (18-19)	47 (43-49)	11 (10-13)	33 (29-35)	20 (19-21)	26 (23-28)	4 --	62955
G. saratogensis	202 (158-236)	59 (46-82)	43 (35-52)	57 (44-74)	17 (12-20)	-- (10-11)	26 (24-27)	-- (7-8)	21 --	10 --	-- (20-21)	-- (4-5)	62956

Abbreviations: L-length, W-width, HL-haptor length, HW-haptor width, Ph-pharynx, C-cirrus, AL-anchor length, ABW-anchor base width, SBL-superficial bar length, DBL-deep bar length, HoL-hook length, HkL-hooklet length.

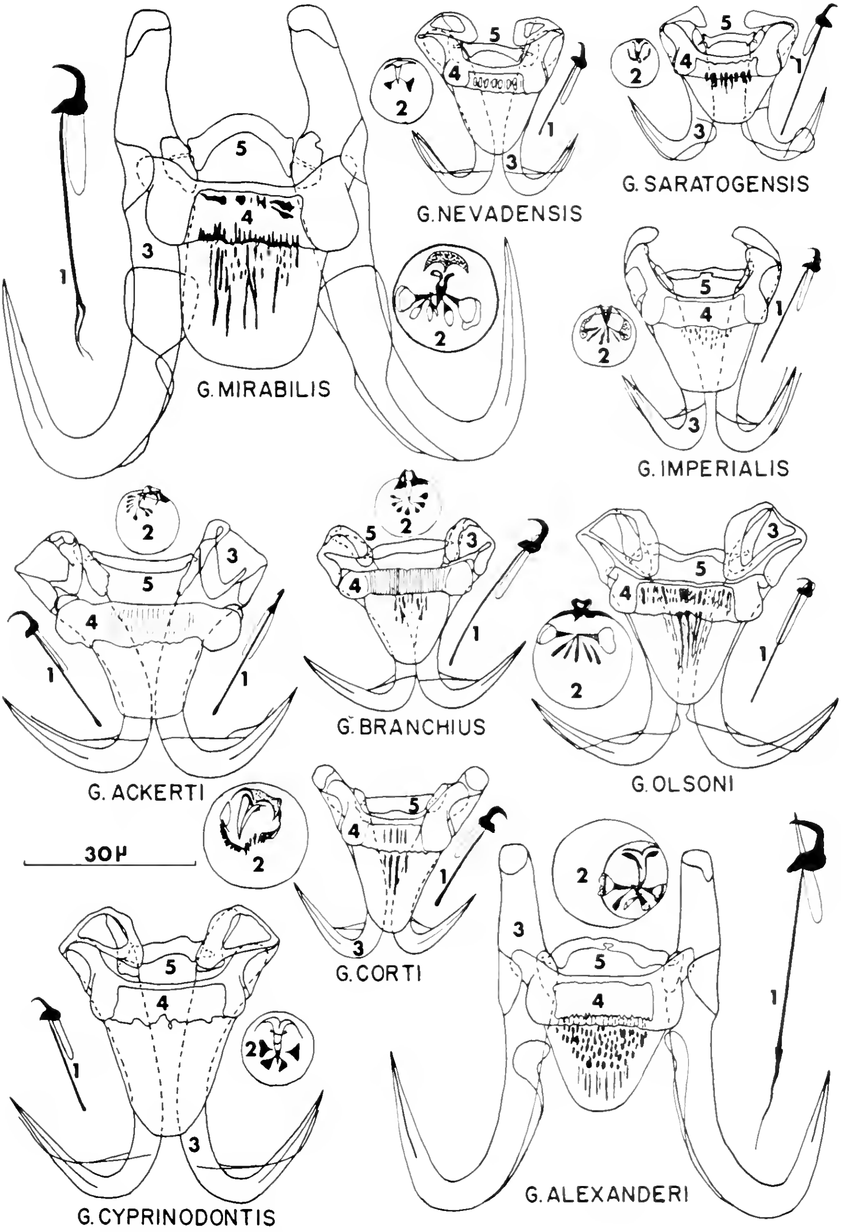

FIGURE 1—Diagnostic morphological characteristics of 10 new species of gyrodactylid parasites of importance to California fishes: 1. hook; 2. cirrus; 3. anchor; 4. superficial bar; 5. deep bar.

point (Figure 1, item 1). Six specimens with two embryos each, others with one each. Cirrus in 16 specimens; with 4–6 spinelets, two lateral larger (Figure 1, item 2). Secondary embryo develops early; sequential development of haptoral armament normal except that hooklet points and shaft irregularly spaced and form irregular circle.

The nearest relative of this species is *Gyrodactylus cucaliae* (Ikezaki and Hoffman, 1957; Kritsky and Mizelle (in press)).

GYRODACTYLUS BRANCHIUS SP. N.

The following description is based on 11 specimens from gills of the starry flounder, *Platichthys stellatus* (Pallas), in Bodega Bay, Sonoma County, California.

Cephalic lobes poorly developed or absent, inconspicuous spicule (or none) in each (or area). Head organs large, extensive. Anterior pharyngeal bulb doughnut shaped, smaller than ovate posterior bulb; gut normal. Peduncle broad; haptor subovate; hook distribution intrahamular. Anchor bases folded mesiad 90°–180°, shafts hollow, folds contact but rarely cover tips of superficial bar in mounted specimens, filament crosses anchor-point arc (Figure 1, item 3). Superficial bar coarsely striated except on knobbed ends; bar shield rounded posteriorly, chromophilic in midportion (Figure 1, item 4). Deep-bar ends well secured in anchor knobs (Figure 1, item 5). Proximal end of hook shanks slightly or not enlarged; hooklet basal border straight or slightly convex, infrequently lightly sclerotized, giving impression of concavity; hooklet shaft stout; hooklet heel reduced; toe with shelf, end diagonally truncate (Figure 1, item 1). FH loop extends 0.5 or less of shank length, terminates undiminished on hooklet shaft. Two specimens with two embryos each, others with one each. Cirrus in seven specimens; with 5–7 subequal spinelets (Figure 1, item 2). Sequential development of haptoral armament normal, development of secondary embryo early.

The nearest relative of *Gyrodactylus branchius* sp. n. is *G. ackerti* sp. n.

GYRODACTYLUS CORTI SP. N.

This description is based on nine specimens from gills and skin of the wolf-eel, *Anarrhichthys ocellatus* Ayres, from Steinhart Aquarium, San Francisco, California.

Cephalic lobes poorly developed or absent, each (or area) with inconspicuous spicule or none. Pharyngeal bulbs ovate; anterior bulb smaller, orifice large. Gut normal, infrequently containing granular material. Peduncle variable; haptor subovate; hook distribution holocentric. Tip of short anchor base with sclerotized cap. Prominent anchor folds secure superficial-bar rami; anchor filament crosses anchor-point arc, *may* extend toward tip (Figure 1, item 3). Superficial-bar shield extends near end of anchor shafts (Figure 1, item 4). Deep bar variable, ends moderately secured in anchor knobs (Figure 1, item 5). Hook shanks with slight to moderate proximal enlargement; hooklet with straight or slightly convex basal border, rounded heel, toe with prominent shelf, shaft stout, point recurved. FH loop extends approximately 0.5 shank length, terminates on hooklet base (Figure 1, item 1). One specimen with two embryos, others with one each. Cirrus in four specimens; with 10–15 spinelets, some forming pecten at times (Figure 1, item 2). Sequential development of haptoral armament and temporal development of secondary embryo normal.

The nearest apparent morphological relative of this species is *Gyrodactylus laruei* Kritsky and Mizelle (in press).

GYRODACTYLUS CYPRINODONTIS SP. N.

This description is based on eight specimens from skin of the Saratoga Nevada pupfish, *Cyprinodon n. nevadensis* Eigenmann and Eigenmann, from Saratoga Springs (Death Valley), Inyo County, California.

Cephalic lobes poorly to well developed, each usually with spicule. Gut normal; pharyngeal bulbs subequal, posterior ovate, anterior subconical with large orifice. Peduncle moderate to broad; haptor fragile, normally fan shaped. Anchor bases perforate, folded mesiad 90°–180°; anchor folds secure rami of superficial bar; anchor filament crosses arc of and often extends along anchor point (Figure 1, item 3). Superficial-bar shield rounded posteriorly (Figure 1, item 4). Deep bar irregular, ends secured deeply in anchor knobs (Figure 1, item 5). Hook distribution extrahamular. Proximal end of hook shanks slightly or not enlarged. Hooklet basal border straight, or slightly concave at or near hook-shank insertion; hooklet heel globose, toe shelfless, shaft inclined, point open or slightly recurved. FH loop extends 0.4–0.5 shank length, terminates on proximal shaft (Figure 1, item 1). One embryo in each specimen. Cirrus in six specimens; with 3–5 wide-based spinelets (Figure 1, item 2). Embryos insufficient to determine developmental sequence of haptoral armament.

The closest relative of *Gyrodactylus cyprinodontis* sp. n. is *G. nevadensis* sp. n.

GYRODACTYLUS IMPERIALIS SP. N.

This species is based on four specimens from skin of the longjaw mudsucker, *Gillichthys mirabilis* Cooper, from the 81st Street drainage canal (Salton Sea), Imperial County, California.

Cephalic lobes poorly to well developed, conspicuous spicule each. Cephalic glands confluent dorsal to esophagus. Pharyngeal bulbs subcircular; anterior slightly larger, orifice large. Gut normal, infrequently with refractile granules. Peduncle of moderate width, infrequently constricted sharply at subcircular haptor. Anchor bases bent mesiad 30°–40°, tips connected by wide band of tissue; anchor filament crosses anchor-point arc, extends to anchor tip (Figure 1, item 3). Superficial-bar rami partially secured under anchor folds; associated-bar shield mildly chromophilic (Figure 1, item 4). Deep bar with wide posterior notch, ends secured deep in anchor knobs (Figure 1, item 5). Hook arrangement extrahamular. Hook shanks with slight or no proximal enlargement; hooklet with globose heel, shelfless toe with basal border receiving hook shank, point recurved. FH loop extends 0.4–0.5 shank length, terminates on hooklet shaft (Figure 1, item 1). Two specimens with two embryos each, others with one. Cirrus in one specimen; with six subequal spinelets (Figure 1, item 2). Embryos insufficient to determine developmental sequence of haptoral armament; temporal development of secondary embryo normal.

The nearest relative of *Gyrodactylus imperialis* sp. n. is *G. colemanensis* Mizelle and Kritsky (in press).

GYRODACTYLUS MIRABILIS SP. N.

This description is based on 11 specimens from skin of the prickly sculpin, *Cottus asper* Richardson, from the Elk River (Eureka), Humboldt County, California.

Cuticle transversely striated in trunk midlength. Cephalic lobes conspicuous; one or two closely associated spicules each. Pharyngeal bulbs ovate, anterior smaller with exaggerated orifice. Cephalic glands often confluent anterior and posterior to pharynx. Gut normal, crura frequently with conspicuous mesial diverticula. Peduncle broad, sharply constricted at subovate haptor; hook arrangement extrahamular. Anchor bases of moderate length, points sharply recurved, anchor filament chromophilic (Figure 1, item 3). Superficial-bar rami secured under anchor folds; bar shield short with rows and lines of chromophilic areas (Figure 1, item 4). Deep bar usually bowed, bilaterally enlarged subterminally, spicular ends secured deep in anchor knobs (Figure 1, item 5). Hook shanks slightly or not enlarged proximally, attenuated distal end attached in notch of hooklet toe, shank ligament double; hooklet point with slight proximal bend and short recurved tip; toe with slanting shelf, depressed tip; hooklet heel globose. FH loop extends 0.4–0.5 shank length, terminates on proximal hooklet shaft (Figure 1, item 1). One specimen with three embryos, two with two each, eight with one each; early embryo lemon-shaped. Cirrus in five specimens; with six spinelets, two laterals larger (Figure 1, item 2). Development of haptoral armament normal, secondary embryo develops early or late.

The nearest relative of this species is *Gyrodactylus cucaliae* (Ikezaki and Hoffman, 1957; Kritsky and Mizelle, in press.)

GYRODACTYLUS NEVADENSIS SP. N.

This species is described from three specimens from skin of the Saratoga Nevada pupfish, *Cyprinodon n. nevadensis* Eigenmann and Eigenmann, from Saratoga Springs (Death Valley), Inyo County, California.

Cephalic lobes poorly developed, conspicuous spicule each. Pharyngeal bulbs ovate, subequal; gut characteristic. Peduncle variable; haptor subovate; hook distribution intrahamular. Anchor bases perforate, folded mesiad approximately 90°; filament crosses anchor-point arc, extends near anchor-point tip (Figure 1, item 3). Superficial-bar rami secured by anchor folds; bar shield subtriangular (Figure 1, item 4). Deep bar bilaterally enlarged subterminally, spicular ends secured deep in anchor knobs (Figure 1, item 5). Proximal end of hook shanks slightly or not enlarged; hooklet heel globose; toe with weak shelf, slight concavity on basal border receives hook shank; hooklet shaft inclined; hooklet point short, slightly recurved. FH loop approximately 0.5 shank length, terminates on hooklet base (Figure 1, item 1). Two specimens with two embryos each, the third with one. Cirrus in one specimen; with two spinelets (Figure 1, item 2). Embryos insufficient to determine sequential development of haptoral armament; secondary embryo develops late.

The nearest relative of *Gyrodactylus nevadensis* sp. n. is *G. cyprinodontis* sp. n.

GYRODACTYLUS OLSONI SP. N.

This species is based on 10 specimens from skin of the longjaw mudsucker, *Gillichthys mirabilis* Cooper, from the 81st Street drainage canal (Salton Sea), Imperial County, California.

External surface and embryos with numerous bacteria (rods and diplococci); vitellaria-like granules in gonadal area. Cephalic lobes poorly to well developed, 1–3 spicules each. Anterior bulb of pharynx subconical, larger than ovate posterior bulb; gut normal. Peduncle moderate to broad, infrequently constricted sharply at subovate or subquadrate haptor. Anchor bases perforate, folded mesiad 90°–180°; anchor filament crosses arc of and continues along anchor point (Figure 1, item 3). Superficial bar chromophilic except ends with short processes secured by anchor folds; associated shield with chromophilic lines (Figure 1, item 4). Deep bar irregular, ends secured deep in anchor knobs (Figure 1, item 5). Hook distribution intrahamular. Hook shanks without proximal enlargement; hooklet with straight or convex basal border, recurved point extending beyond vertical from toe tip, heel mildly globose, shelfless toe with blunt tip. FH loop extends 0.4–0.5 shank length, terminates undiminished at union of hooklet shaft and point (Figure 1, item 1). Two specimens with two embryos each, others with one. Cirrus in three specimens; with seven spinelets, two laterals larger (Figure 1, item 2). Developmental sequence of haptoral armament and temporal development of secondary embryo normal.

The nearest relative of this species is *Gyrodactylus perforatus* Mizelle and Kritsky (in press).

GYRODACTYLUS SARATOGENSIS SP. N.

This description is based on three specimens from skin of the Saratoga Nevada pupfish, *Cyprinodon n. nevadensis* Eigenmann and Eigenmann, from Saratoga Springs (Death Valley), Inyo County, California.

Cephalic lobes incipient, inconspicuous spicule each (or none). Gut normal; pharyngeal bulbs subequal, anterior subconical, posterior ovate. Peduncle broad; haptor subcircular. Anchor bases folded mesiad approximately 90°. Anchor folds secure superficial-bar rami; anchor filaments arise on shafts, continue along broadly recurved points (Figure 1, item 3). Posterior border of superficial bar chromophilic, shield short and wide (Figure 1, item 4). Deep bar bilaterally enlarged subterminally, attenuated ends inserted deep in anchor knobs (Figure 1, item 5). Hook distribution extrahamular. Hook shanks without proximal enlargement; basal border of hooklet straight or slightly convex; hooklet point open or slightly recurved, toe shelfless, heel globose. FH loop extends 0.3–0.5 shank length, terminates on hooklet base (Figure 1, item 1). One specimen with two embryos, others one each. Cirrus in each specimen; with 0–5 spinelets (Figure 1, item 2). Embryos insufficient to observe developmental sequence of haptoral armament; secondary embroyo develops late.

The nearest relative of *Gyrodactylus saratogensis* sp. n. is *G. cyprinodontis* sp. n.

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A SEROLOGICAL ANALYSIS OF THREE POPULATIONS OF GOLDEN TROUT, *SALMO AGUABONITA* JORDAN[1]

JOHN R. CALAPRICE
Inland Fisheries Branch, California Department of Fish and Game[2]

JOHN E. CUSHING
Department of Biological Sciences
University of California, Santa Barbara

Three populations of golden trout were compared using erythrocyte antigens. Two of the populations are from streams isolated from one another and within the ancestral home range of the species: Golden Trout Creek and South Fork of the Kern River. The third, from the originally barren Cottonwood Lakes, was started with 12 trout introduced from the South Fork of the Kern River some 90 years earlier. The populations were compared using agglutination scores and the distinction coincided with historic considerations. Golden trout from Golden Trout Creek differed significantly from both Cottonwood Lakes and South Fork of the Kern River goldens, while no significant difference was detected between goldens from the Cottonwood Lakes and the South Fork of the Kern River.

INTRODUCTION

Calaprice and Cushing (1964) examined the erythrocyte antigens of rainbow trout (*Salmo gairdnerii*), golden trout (*Salmo aguabonita*), brown trout (*Salmo trutta*), Lahontan cutthroat trout (*Salmo clarkii henshawi*), and eastern brook trout (*Salvelinus fontinalis*). The pattern of erythrocyte agglutinations displayed by these species demonstrated antigenic diversity useful in population studies.

This report is an analysis of erythrocyte antigens within and among three populations of golden trout. Populations from the South Fork of the Kern River and Golden Trout Creek in Tulare County in the eastern Sierra Nevada of California are within the ancestral home range of the species. The third population was established some 90 years ago with fish taken from the South Fork of the Kern River and placed in the barren Cottonwood Lakes in Inyo County.

Evermann (1906) compiled an informative list of accounts of the early transplants of golden trout which tells of the establishment of the Cottonwood Lakes population. This record indicates that 12 golden trout from the South Fork of the Kern River were first introduced into Cottonwood Creek in 1876. In 1891, fish from the creek were taken to the Cottonwood Lakes. Since then, golden trout from the Cottonwood Lakes have been used extensively in transplanting programs (Ellis and Bryant, 1920). Since there are no records of additional transplants among the three populations, the situation afforded an opportunity to test the method of using erythrocyte antigens in population discrimination.

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[2] Now with the Fisheries Research Board of Canada, Pacific Coast Biological Station, Nanaimo, British Columbia.

MATERIALS AND METHODS

The research was conducted at the California Department of Fish and Game spawning station at Cottonwood Lakes in June 1963, and at the U.S. Fish and Wildlife Service Convict Creek Experiment Station, Mono County, in August 1963.

Golden trout used in the study were taken by trapping at Cottonwood Lakes 1, 2, 3, 4, and 5 in June 1963. Fish from Golden Trout Creek were collected at Big Whitney Meadows by fly fishing, and those from the South Fork of the Kern were collected approximately 2 miles east of Tunnel Ranger Station in the same manner.

Intrapopulation variation was first studied at the Cottonwood Lakes. Also, live fish from all three areas were transported by pack train and airplane to Hot Creek Fish Hatchery in Mono County for later analysis. Rainbow trout used in the study were of the Mt. Whitney Hatchery spring-spawning domesticated strain.

Blood samples were obtained by heart puncture. Several cubic centimeters of whole blood were drawn into a syringe partially filled with modified Alsever's solution (*see* Sprague and Vrooman, 1962). The erythrocytes were washed by centrifugation and resuspension in fresh Alsever's solution. No difficulties were experienced in storing blood samples for several days in snowbanks at the Cottonwood Lakes. Agglutination tests were made with capillary tubes and/or slide agglutination plates. The reactions were scored (−) for no agglutination and 1, 2, 3, and 4 for positive reactions representing increasing degrees of agglutination. In addition very faint reactions were recorded as traces (tr). As the study progressed, it was found that the capillary tube method used smaller amounts of reagent, and by minimizing evaporation, the tests could be read after a longer period of time. This permitted the detection of reactions not possible with the slide test. The capillary tube technique therefore became the standard method.

The testing sera used in the study were absorbed and unabsorbed immune sera. Immune sera were prepared by injecting rabbits with 1 cc of rainbow or golden trout erythrocytes daily for a period of 7 days. After 14 days, the rabbits were bled and the serum removed from the whole blood and frozen. Absorbed sera were prepared by mixing equal volumes of this whole immune serum (diluted one in four with Alsever's solution) and washed packed erythrocytes from individual fish. The mixtures were gently agitated for periods up to 30 minutes, centrifuged and the red blood cells with their attached antibodies discarded. The supernatants, now absorbed sera, were then frozen until used in the tests.

RESULTS

Intrapopulation Variation: Cottonwood Lakes

Intrapopulation antigenic variation within the Cottonwood Lakes fish was studied using coded samples of washed erythrocytes.[3] A number of immune sera were tested with samples of Cottonwood fish erythrocytes. Among these, anti-golden serum 27 and anti-rainbow serum 26 were the most useful in establishing the presence of antigenic variation (Table

[3] Each fish was photographed after bleeding and the antigenic variation compared with morphological variation. The results of this comparison will be discussed in a subsequent report.

1). Anti-golden serum 27 was prepared by injecting a rabbit with a pool of washed erythrocytes taken from fish of the Golden Trout Creek strain collected from Laurel Lakes, Mono County. Anti-rainbow serum 26 was prepared by immunizing a rabbit with the washed erythrocytes of one large spring-spawning rainbow trout of the Mt. Whitney Hatchery strain.

TABLE 1

Examples of the Reactions of the Erythrocytes of Cottonwood Lakes Golden Trout with Unabsorbed and Asorbed Anti-rainbow and Anti-golden Sera

		Anti-rainbow 26						Anti-golden 27						
		Unabsorbed serum				Absorbed serum		Unabsorbed serum				Absorbed serum		Alsever's control
Serum dilution		1/8	1/16	1/32	1/64	1/4	1/8	1/128	1/256	1/512	1/1024	1/16	1/32	
FISH	A	4	3	2	1	2	1	1	1	tr	--	tr	--	--
	B	4	2	1	1	2	--	2	1	--		2	1	--
	C	4	3	2	1	-	--	2	1	-	--	1	tr	--
	D	4	3	2	1	--	--	1	1	tr	--	--	--	--
	E	3	2	1	--		-	3	1	--	--	-	--	--
	F	4	2	1	-		--	3	3	2	--	1	tr	--
	G	4	2	1	--	--	--	3	3	2	--	1	--	--
Golden	H	3	2	1	--	-	-	2	tr	--	--		--	--
	I	4	4	2	1	4	1	2	1	-	--	2	tr	--
	J	4	4	2	1	3	2	2	1	--	--	1	tr	--
	K	4	3	2	*	4	3	2	1	tr	-	-	--	-
	L	4	3	2	*	1	--	2	1	--	--	3	2	--
	M	4	3	2	*	1	--	3	tr	-	--	tr	-	--
	N	4	3	2	*	--	--	3	3	2	tr	1	--	--
	O	4	3	2	*	--	--	3	2	tr	--	tr	--	--
	A	*	*	*	*	4	4	3	2	--	--	--	--	--
Rainbow	B	*	*	*	*	4	3	2	1	--	--	--	--	--
	C	*	*	*	*	4	3	1	tr	--	--	--	--	--

* Not tested.

The results of tests with anti-golden serum 27 demonstrated a considerable diversity characteristic of the variation described by Calaprice and Cushing (1964). A portion of this serum was absorbed with pooled erythrocytes of three rainbow trout (Mt. Whitney spring-spawning strain) brought to the lakes for this purpose. Individual Cottonwood Lakes fish were retested with this absorbed serum and the results compared with those obtained with the corresponding unabsorbed serum. Antigenic diversity was even more obvious using absorbed sera.

Anti-rainbow serum 26 was also used on these Cottonwood goldens. Additional tests were made with part of the serum that had been absorbed with the cells of fish that gave weak agglutination reactions. These tests also distinguished individual antigenic variations. The reactions of several rainbow trout are included for comparison in Table 1. The results of these tests show that antigenic diversity can be demonstrated within the Cottonwood Lakes population and that it may be possible to classify the fish into antigenic categories particularly in their reactions with absorbed sera. This possibility has not yet been systematically investigated.

Intrapopulation Variation: Golden Trout Creek

Samples from the Golden Trout Creek population of goldens, when tested with the same unabsorbed anti-rainbow and anti-golden sera, also gave a varied pattern of agglutination scores. Again, it was possible to refine the distinction by absorption (Table 2).

TABLE 2

Examples of the Reactions of the Erythrocytes of Golden Trout Creek Golden Trout with Unabsorbed and Absorbed Anti-rainbow and Anti-golden Sera

		Anti-rainbow 26						Anti-golden 27						
		Unabsorbed serum				Absorbed serum		Unabsorbed serum				Absorbed serum		Alsever's control
Serum dilution		1/128	1/256	1/512	1/1024	1/4	1/8	1/64	1/128	1/256	1/512	1/4	1/8	
FISH	A	2	1	tr	--	-	--	2	tr	--	--	--	--	--
	B	2	1	--	--	--	--	4	4	2	tr	tr	--	--
	C	2	tr	--	--	1		3	3	tr	--	tr	--	--
	D	2	tr	--	--	--	--	3	2	1	--	1	tr	--
	E	2	1	--	--	-	-	3	2	1	--	--	--	--
	F	2	tr	--	--	1	--	3	2	1	tr	--	--	--
	G	2	tr	--	--	tr	--	3	2	1	--	--	--	--
Golden	H	3	2	1	--	1	-	1	tr	--	--	*	*	--
	I	2	1	--	--	1	-	*	*	*	*	--	--	--
	J	1	tr	-	--	-		2	1	--	-	1	--	--
	K	2	1	tr	--	tr	--	--	-	--	-	*	*	--
	L	2	1	tr	-	1		3	2	tr	--		--	--
	M	2	2	1	tr	2	tr	1	--	--	--	*	*	--
	N	3	2	1	tr	1		1	--	--	--	*	*	--
	O	4	1	tr	-	tr	-	3	1	--	--	*	*	--
	A	3	1	--	-	3	2	3	1	--	--	*	*	--
	B	1	tr	-		1		tr	--	--	--	-	-	--
Rainbow	C	3	2	1	tr	3	2	2	--		--	-	-	--
	D	2	1	tr	--	3	2	3	3	1	tr	*	*	--
	E	3	2	1	--	2	1	2	--	--	--	*	*	--

* Not tested.

The absorbed immune sera used in this study were essentially the same as reported earlier, but differed as follows. The absorbed anti-rainbow serum was prepared by absorbing serum 26 with an additional sample of pooled erythrocytes from the same golden trout used in the earlier absorption (Cottonwood study). By the nature of the absorption technique, a second absorption of this reagent may be expected to give somewhat different results, since it is very difficult to duplicate dilutions, number of erythrocytes, etc. The absorbed anti-golden serum was also prepared at a later date, using rainbow erythrocytes from individual fish.

Both absorbed reagents were useful in distinguishing distinct antigenic types within the sample. As in the case of the Cottonwood Lakes study, individual fish reacted variably with the absorbed reagents.

Intrapopulation Variation: South Fork of the Kern Population

Golden trout from the South Fork of the Kern River also were tested with anti-rainbow and anti-golden sera, using the same absorbed immune sera that differentiated members of the Golden Trout Creek population. In these, all of the South Fork of the Kern goldens tested gave negative reactions with absorbed anti-golden trout serum. Test scores with unabsorbed anti-rainbow serum showed reaction patterns somewhat similar to those given in Table 2.

Interpopulation Antigenic Variation

Golden trout from Golden Trout Creek, South Fork of the Kern River, and Cottonwood Lake 3 were assembled at the U.S. Fish and Wildlife Service Convict Creek Experiment Station. Inasmuch as the reactivity of reagents and cells alike is affected by microvariations in dilution and may change during storage, samples from all three populations were bled in the same manner, on the same day, and tested with the same absorbed and unabsorbed immune sera, thereby minimizing experimental error.

The reagents used in this study were those described in the Golden Trout Creek and South Fork of the Kern intrapopulation study. Absorbed anti-rainbow serum 26 distinguished two antigenic classes of fish in each population (Table 3). For purposes of the following analysis, all scores at the $\frac{1}{4}$ dilution of tr, 1, 2, 3, 4 were considered positive and (—) negative. The hypothesis that all three samples from the various areas were drawn from the same population was then tested by comparing the relative frequencies of the antigenic types in all possible combinations, using a 2 $\times$ 2 contingency table at each of two dilutions (Siegel, 1956). The results indicate that the Cottonwood Lake fish (Lake 3) and those of the South Fork of the Kern River do not differ significantly. In contrast, Golden Trout Creek goldens differ significantly from both Cottonwood Lake and South Fork of the Kern River goldens. The conclusions reached are essentially the same, regardless of the dilution used in the comparison (Table 4). This analysis also shows that the frequency of "rainbow-like" antigens is higher in the Cottonwood and South Fork of the Kern population than in the Golden Trout Creek population.

TABLE 3

Reactions of Three Populations of Golden Trout with Anti-rainbow Trout Serum 26 Absorbed with a Pool of Cottonwood Lake Fish Erythrocytes

	Fish no.	1/4	1/8	C*	Fish no.	1/4	1/8	C*	Fish no.	1/4	1/8	C*	Fish no.	1/4	1/8	C*
South Fork of the Kern	1	tr	--	--	7	1	--	--	13	--	--	--	19	2	1	--
	2	2	--	--	8	2	tr	--	14	4	4	--	20	--	--	--
	3	1	--	--	9	3	2	--	15	tr	--	--	21	--	--	--
	4	2	1	--	10	1	--	--	16	3	2	--	22	--	--	--
	5	1	--	--	11	2	1	--	17	3	2	--	23	--	--	--
	6	1	--	--	12	4	3	--	18	tr	--	--	24	3	2	--
Cottonwood Lakes	1	2	tr	--	7	3	2	--	13	2	tr	--	19	--	--	--
	2	2	1	--	8	2	1	--	14	1	--	--	20	2	--	--
	3	1	--	--	9	1	tr	--	15	--	--	--	21	2	1	--
	4	2	1	--	10	1	--	--	16	--	--	--				
	5	2	2	--	11	2	1	--	17	--	--	--				
	6	--	--	--	12	2	1	--	18	--	--	--				
Golden Trout Creek	1	--	--	--	10	--	--	--	19	1	--	--	28	--	--	--
	2	--	--	--	11	tr	--	--	20	1	--	--	29	--	--	--
	3	1	--	--	12	1	--	--	21	2	1	--	30	--	--	--
	4	--	--	--	13	2	tr	--	22	--	--	--	31	3	1	--
	5	--	--	--	14	1	--	--	23	--	--	--	32	--	--	--
	6	1	--	--	15	tr	--	--	24	--	--	--	33	--	--	--
	7	1	--	--	16	--	--	--	25	--	--	--	34	--	--	--
	8	1	--	--	17	tr	--	--	26	tr	--	--	35	--	--	--
	9	1	--	--	18	--	--	--	27	--	--	--	36	--	--	--
Mt. Whitney rainbow	1	3	2	--	3	3	2	--	5	2	1	--				
	2	1	--	--	4	3	2	--	6	1	--	--				

* Alsever's control.

TABLE 4

Comparison of the Relative Frequencies of Two Antigenic Classes Within Three Populations of Golden Trout as Defined By Reactions with Absorbed Anti-rainbow Serum 26

	Populations compared											
	South Fork of Kern River		Cottonwood Lake 3		Golden Trout Creek		Cottonwood Lake 3		South Fork of Kern River		Golden Trout Creek	
Frequency[1]	+	−	+	−	+	−	+	−	+	−	+	−
at dilution 1/4	19	5	15	6	16	20	15	6	19	5	16	20
1/8	10	14	11	10	3	33	11	10	10	14	3	33
Fisher's exact probability[2] at dilution 1/4	0.3983 n.s.				0.0438				0.0072			
1/8	0.3376 n.s.				0.0003				0.0031			

[1] The positive class includes scores of tr, 1, 2, 3, and 4.
[2] n.s. shows that the samples do not differ significantly at the 5% level.

DISCUSSION

Intrapopulation Antigenic Diversity

The results with unabsorbed sera indicated that considerable antigenic diversity exists within each population of golden trout. This diversity was made more distinct by absorbing anti-rainbow and anti-golden immune sera with erythrocytes from fish chosen on the basis of test scores. Although intrapopulation differences were not studied in detail, fish tested with anti-golden immune serum absorbed with a pool of rainbow trout erythrocytes and anti-rainbow serum absorbed with a pool of golden trout cells could be tentatively assigned to four classes.

A small sample of rainbow trout erythrocytes has been included for comparative purposes. Goldens with "rainbow-like" antigens appeared in each population, with a greater number showing up in the South Fork of the Kern and Cottonwood populations. It was on the basis of these differences that the following comparisons could be made.

Interpopulation Antigenic Variation

The results of comparisons of antigenic variations under controlled conditions show that some "rainbow-like" antigens appear to be prevalent in each population; however, the frequencies differ among populations. Specifically, it has been possible to distinguish between samples of golden trout from Golden Trout Creek and the South Fork of the Kern River on the basis of reactions with anti-rainbow serum absorbed with golden trout erythrocytes. The sample of golden trout from Cottonwood Lake 3 did not differ significantly from the South Fork of the Kern River sample, but did differ from the Golden Trout Creek sample. The results also show that a higher frequency of "rainbow-like" antigens is present in the Cottonwood Lakes and South Fork of the Kern River populations than is present in the Golden Trout Creek population.

The observation that the Cottonwood fish closely resemble those of the South Fork of the Kern River is not at first surprising, since they are descended from fish planted from that river. Theoretically, however, some differences should have arisen between the populations since they were first isolated from each other some 90 years ago. Since Cottonwood fish are all derived from an initial plant of 12 fish, one would expect differences between them and the South Fork of the Kern River fish, for the following reasons. First, there is the probability that the initial sample used to populate the Cottonwood Lakes was too small to be representative of the South Fork of the Kern River fish. Second, it is likely that genetic drift might have acted to differentiate the populations. Third, it is also likely that the populations may have been subjected to differential selection pressures derived from the obvious differences between stream and lake environments. In view of these considerations, it is apparent that the close antigenic similarity of the two populations presents an interesting evolutionary problem.

The antigenic differences noted between the South Fork of the Kern River and Golden Trout Creek populations are more easily understandable, for they agree with distinctions between the two populations on the basis of spotting and morphological characters (Evermann, 1906). These differences would be expected to arise through the action of the evolutionary forces referred to above.

The antigenic comparisons also relate to an interesting problem brought about through the action of ranchers who in 1883 dug a tunnel which diverted water from Golden Trout Creek into the South Fork of the Kern River. The tunnel soon caved in and was made into an open ditch which also soon caved in, causing the project to be abandoned. The amount of genetic mixing that may have occurred as a result of these operations cannot be estimated. However, the close antigenic resemblance of Cottonwood and South Fork of the Kern River fish suggests that little genetic mixing took place.

Part of the stimulus for the study involved the presence of "rainbow-appearing" trout in the Cottonwood Lakes and in lakes planted with progeny from Cottonwod Lakes trout. It was suggested that this was due to rainbow-golden hybridization in the Cottonwood Lakes. The results of this study do not support this belief, for "rainbow-like" antigens were found in both the parent South Fork of the Kern River and Cottonwood Lakes populations in about equal frequency. However, hybridization is not the only factor which can lead to the existence of occasional "rainbow-appearing" trout in the Cottonwood Lakes. This condition could be due to genetic factors related to the history of the strain and its development in the lake environment, or to factors involved in hatchery propagation, such as selections during egg-taking operations and rearing and feeding in a hatchery environment. Differences in appearance may be just one aspect of genetic change inadvertently brought about by such egg-taking operations.

Results of this study confirm the findings of Calaprice and Cushing (1964) that there is considerable recognizable antigenic diversity within populations of golden trout. This diversity has been brought out by agglutination tests with absorbed sera. The conclusion that such characters could be used by fisheries investigators appears to be supported by the findings of Utter and Ridgway (1966), which demonstrate the feasibility of using similar techniques in studying the effects of inbreeding in Lahontan cutthroat trout populations.

Analysis of antigenic characters within populations in this study is of interest in that the history of the populations was known and distinctions based on these characters, using small samples of fish, agree with historic considerations. The results are not considered conclusive, since further distinctions between stream and lake populations of the same strain may be possible, using either different reagents or larger samples. Considering the relative ease of separation of the populations with qualitative tests, and the limited time which could be devoted to the study, we are led to conclude that it should be feasible to extend such studies using erythrocyte antigens either alone or in conjunction with other serum constituents (Grunder, 1966) on golden trout populations. Quantification of the immunological method along with the multivariate analysis should increase the power of establishing existing differences among populations.

Golden trout are of particular interest in that many populations were established at about the same time and from the same parent stock. Many of the lakes are in remote areas of the Sierra Nevada in California and consequently are little disturbed by the activities of man. On the other hand, maintenance stocking of young fish is an exception, but in itself provides an opportunity to study selection using conceptual models similar to those of Workman, Blumberg, and Cooper (1963). The golden trout is not the only species whose range has been extended by transplants of small numbers of fish. Many other freshwater game fish populations in California have been introduced from different areas of the country, and the available records indicate that in some instances only a few fish, and thus a relatively small sample of the gene pool, were used to establish populations. One would expect genetic changes under such conditions. Considerations and studies which are directed at evaluating genetic and ecological differences within populations could provide data for students of evolution and be the basis for management practices which are biologically sound.

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JAW INJURY AND CONDITION OF KING SALMON[1]

BRUCE A. FULMER[2] and RICHARD L. RIDENHOUR
Humboldt State College
Arcata, California

Examination of 84 fall-run king (chinook) salmon, *Oncorhynchus tshawytscha*, caught in the Mad and Eel rivers of California during 1965 showed a significant negative relationship between healed jaw injuries and condition factor. Among uninjured and slightly injured fish, age, sex, and stream showed no significant relationship with condition but a significant decrease in condition was noted as the season progressed, and as the color of the fish darkened. Serious effects of the ocean troll fishery beyond direct hooking mortality are implied and warrant additional study.

Casual observation of salmon caught in fresh water by sportsmen has suggested that poor condition is related to old jaw injuries. Data were collected during the fishing season of 1965 to evaluate this relationship.

Jaw injuries may occur when fish are hooked and released or when they escape from the ocean troll fishery. The survival of sublegal salmon caught and released by this fishery has concerned biologists for some time (Milne and Ball, 1956; Parker and Black, 1959; and Lasater and Haw, 1961). However, sublethal effects could be as important as direct mortality in regulating salmon populations. If the condition of released fish is affected adversely, their reproductive potential and production are reduced.

Eighty-four fall-run king salmon were examined. These fish were caught from the Mad and Eel rivers of north coastal California by sportsmen between September 30 and November 15, 1965. Each fish was classified into one of the following categories:

Uninjured—no evidence of an old injury to the jaw.

Slightly Injured—evidence of a healed injury in the form of scar tissue but without distortion of the jaw structure (often this category included fish with torn or missing maxillaries).

Moderately Injured—evidence of a healed injury which resulted in some distortion and/or displacement of the jaw structure (Figure 1).

Extensively Injured—evidence of a healed injury which resulted in extensive distortion and/or displacement of the jaw structure (Figure 2).

The fork length (to the nearest one-eighth inch) and the weight (to the nearest one-tenth pound) of each fish were recorded for computation of the condition factor. Scale samples were taken for age determinations. Additional factors, that conceivably could have affected the condition of the salmon and were recorded, included sex, date of catch, external

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[2] Present address: Exchequer Dam, Snelling, California.

FIGURE 1—Chinook salmon showing healed jaw injury classified as "moderate". Fish caught from Eel River, October 9, 1965: Age = 1+, FL = 23 inches, W = 5.6 pounds, C = 46.0. *Photograph by Leland Rossi.*

FIGURE 2—Chinook salmon showing healed jaw injury classified as "extensive". Fish caught from Eel River, October 9, 1965: Age = 1+, FL = 21.25 inches, W = 4.1 pounds, C = 39.9. *Photograph by Leland Rossi.*

coloration (as an indication of time spent in fresh water and classified as silver bright, slightly copper, copper, or dark), and stream of catch.

The condition factor was computed for each fish ($C = 100{,}000\ W/L^3$). Average condition of all fish was 45.4, with a range from 24.1 to 55.1.

Summaries were made to evaluate the effects of various factors other than injury (Table 1). Data used in these evaluations were restricted to reduce potential interactions. There was no indication that age, sex, or stream was related to the condition of the fish. There was a significant decrease in condition as the season progressed and a barely significant difference between silver bright and copper colored fish. The condition factor of uninjured and slightly injured 1+ fish decreased from 51.1 to 43.1 during a 4-week period.

The average condition factor was reduced significantly as the degree of jaw injury increased (Table 2). The analysis was restricted to the 1+ fish since few older fish were caught, although the limited data from older fish tends to support the conclusions based on the 1+ fish. The condition factor for slightly injured fish averaged 47.5, which was only slightly less than the 48.2 average for uninjured fish. However, the condition factor for moderately injured fish averaged only 40.6 and for extensively injured fish only 36.5. Although there was no significant difference between the conditions of uninjured and slightly injured fish and between the conditions of moderately injured and extensively injured fish, all other differences were highly significant. The decreased condition as the season progressed had no appreciable influence on the

TABLE 1

Factors and Their Influence on the Condition Factor of Upstream Migrating King Salmon Caught in 1965

Only Uninjured and Slightly Injured Fish Are Included

Category	Sample size	Condition factor		
		Mean	Standard deviation	Range
Age				
1+	51	48.0	4.27	38.6–55.1
2+	1	43.2	----	----------
3+	9	47.0	4.70	39.8–53.2
Sex[1]				
Male	5	47.5	5.75	43.2–53.2
Female	5	45.9	3.58	42.4–50.6
Date of Catch[2]				
9/27–10/3	8	51.1	3.27	47.1–55.1
10/4–10/10	21	49.2	3.58	43.7–55.1
10/11–10/17	15	46.5	4.03	38.6–53.3
10/18–10/24	5	43.1	3.22	41.1–48.8
10/25–10/31	1	40.8	----	----------
11/1–11/7	1	49.4	----	----------
Color[2]				
Silver bright	35	48.2	4.26	38.6–55.1
Slightly copper	13	48.5	4.15	40.8–55.0
Copper	3	42.8	0.83	42.2–43.7
Stream[2]				
Mad River	26	46.9	4.32	38.6–55.1
Eel River	25	49.1	4.00	42.2–55.1

[1] Includes only age 2+ and 3+ fish.
[2] Includes age 1+ fish.

TABLE 2

Jaw Injury as Related to the Condition Factor of Upstream Migrating King Salmon Caught in 1965

Degree of injury	Sample size	Condition factor		
		Mean	Standard deviation	Range
Age 1+ fish				
Uninjured	32	48.2	4.16	38.6–55.1
Slightly injured	19	47.5	4.52	41.1–55.1
Moderately injured	15	40.6	5.27	24.1–46.0
Extensively injured	6	36.5	4.36	29.2–40.0
Age 2+ fish				
Uninjured	1	43.2	----	----------
Slightly injured	0	----	----	----------
Moderately injured	0	---	----	----------
Extensively injured	1	34.4	----	----------
Age 3+ fish				
Uninjured	5	46.1	5.34	39.8–53.2
Slightly injured	4	48.2	4.18	42.4–51.8
Moderately injured	1	34.7	----	----------
Extensively injured	0	----	----	----------

relationship between condition and degree of injury, since there was no significant change in the proportion of injured fish as the sampling period progressed. Actually, the main effect of changes in condition with time was to increase variation and, therefore, reduce the significance of observed differences.

If it is assumed that most or all of the injuries resulted from the fish being hooked by the ocean troll fishery, the overall effect of that fishery on the salmon resource can be evaluated in broad terms. Again considering only the 1+ fish, over 50% (40/70) showed evidence of an old jaw injury. Other estimates have suggested that at least 50% of fish caught and released by the troll fishery die (Milne and Ball, 1956; Parker and Black, 1959). This would indicate that the troll fishery hooks approximately two-thirds of the salmon while they are still sublegal in size. Further, over 50% (21/40) of the injured fish were moderately or extensively injured, so that their condition was adversely affected. The potential effects of a decreased condition on spawning fish are obvious. Any factor which limits the ability of the fish to reproduce will reduce production. An objective evaluation of these effects would be most difficult.

The implications of these data are serious and a comprehensive study and analysis should be conducted. Particularly, data from older fish should be obtained, since an evaluation based primarily on precocious males has limited value.

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NOTES

A PORTABLE RECEIVER FOR HOLDING LIVE FISH

A portable receiver for holding live northern anchovies (*Engraulis mordax*) was needed aboard vessels for tagging work in California's inshore waters. Complete portability was required, so that the unit could be transported in autos and skiffs, and easily set up in the water. A ruggedness to withstand hard use also was needed. The unit described meets these requirements, and is used for holding tagged fish before their release into the ocean.

The circular receiver is 10 feet in diameter by 6 feet deep and weighs 22 pounds; the sides are of nylon netting; cork and lead lines are shaped with $\frac{3}{4}$-inch (i.d.) plastic pipe (Figure 1). Large composition-sponge net floats hold the cork line above the surface of the water, and a braided lead line, passed through the bottom pipe and dropped inside the netting, holds down the bottom. Plastic "T" pipe fittings connect the ends of the pipe to form a circle. Although ocean surge action has no effect on the receiver, a strong side current will cause the bottom to rise. Additional weights placed along the lead line on the side of the receiver facing the current will correct this.

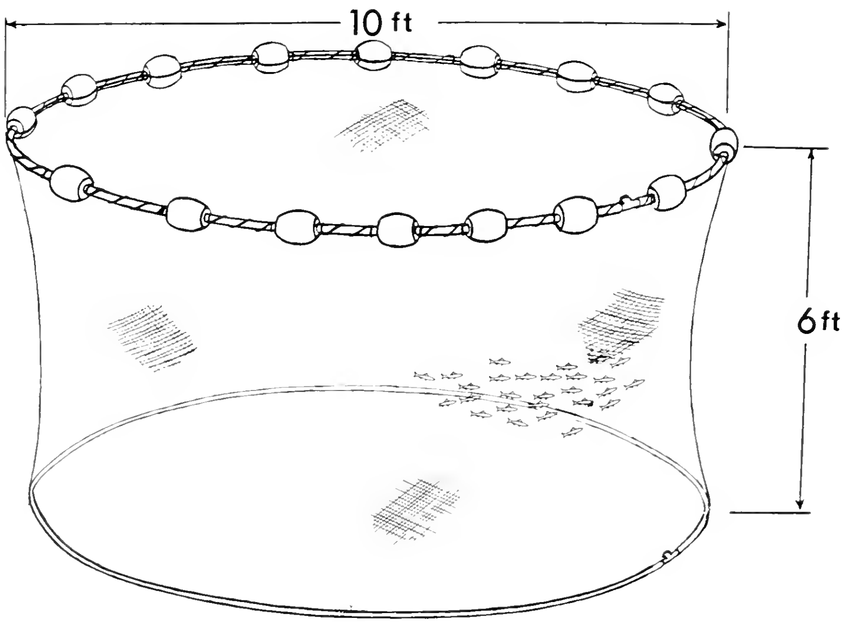

FIGURE 1—Diagrammatic view of the receiver in water.

Collapsing the receiver for transport is easily accomplished by twisting the pipe into a "figure 8", and then folding one loop of the "8" over the other (Figure 2).

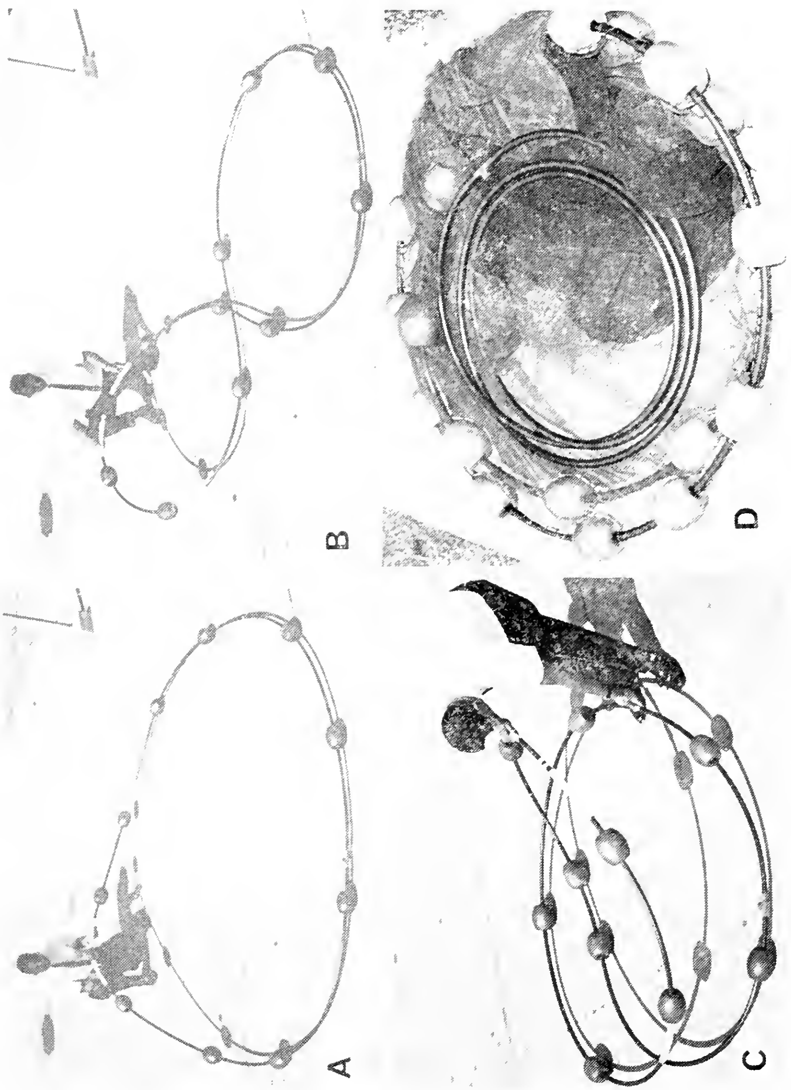

FIGURE 2—Folding the receiver for transport. A, receiver positioned ready to be folded (for clarity only the cork line is shown); B, folded into "Figure Eight"; C, folding one loop of the "8" over the other; D, receiver ready for transport, with the lead line folded inside the cork line. *Photographs by Jack W. Schott.*

The unit is constructed of the following:

Netting: Nylon Soft Lay, "Newlon", ½-inch mesh, 2 fathoms by 300 meshes deep (approximately 6 feet).

Pipe: Plastic, underground sprinkler, "Poly-Pipe", 64 feet.

Floats: Composition sponge "Spongex" by B. F. Goodrich, 5 inches by 4½ inches, 1-inch hole diameter.

Lead Line: 32 feet.
"T" Fittings: Plastic sprinkler connections.

All of the above materials were purchased from local hardware or net dealers at a total cost of $42.

We wish to thank Andrew Vrooman, U.S. Bureau of Commercial Fisheries, La Jolla, for ideas regarding the original design, and Donald A. Carvalho, Net Man and Boatswain, California Department of Fish and Game, for assistance in constructing the receiver.

—*Richard Wood and Robson A. Collins, Marine Resources Operations, California Department of Fish and Game, September 1966.*

AN INTERNAL CAPSULE FISH TAG

A fish tag in the form of a capsule inserted into the coelom has performed satisfactorily in preliminary aquarium tests. Lack of time and facilities for continuing the experiments has prompted a note at this time, for the interest of workers directly involved in the design and testing of fish tags.

The tag consists of a message enclosed in a small inert plastic capsule to which a flat flexible streamer is attached. The capsule is inserted into the body cavity through a small slit made with a scalpel, just to one side of the midline. When the fish swims, the streamer is swept back along the body.

The tag combines the advantages of the hydrostatic capsule and the body cavity tag in that it:

1) presents little external hindrance to swimming and related activities;
2) allows for fish growth without tag loss;
3) does not make fish more vulnerable to fishing gear;
4) provides ample space for messages;
5) is inconspicuous to most prey and predators, but is sufficiently detectable when fish are removed from water.

For aquarium tests, tag capsules were made of 25-mm sections of transparent neoprene tubing (3-mm inside diameter). Streamers, 3 mm × 100 mm, were cut from colored vinyl upholsterer's plastic. Messages were written on 13-mm × 25-mm sheets of white vinyl.

The tag was assembled by inserting the streamer through a transverse slit in the middle of the tubing and heat sealing it into one end of the tag, as shown in Figure 1. The rolled message was then inserted, and the other end of the tubing sealed. After trimming the ends, the finished tag measured 23 mm × 4 mm, with an 87-mm streamer.

In aquarium tests on rock bass, *Ambloplites rupestris*, five tagged fish (146 mm to 182 mm TL) competed successfully with four control specimens of similar size for 76 days, at which time all fish were removed. In another experiment a tagged rock bass was maintained for 100 days with no apparent loss of vigor or condition, although subse-

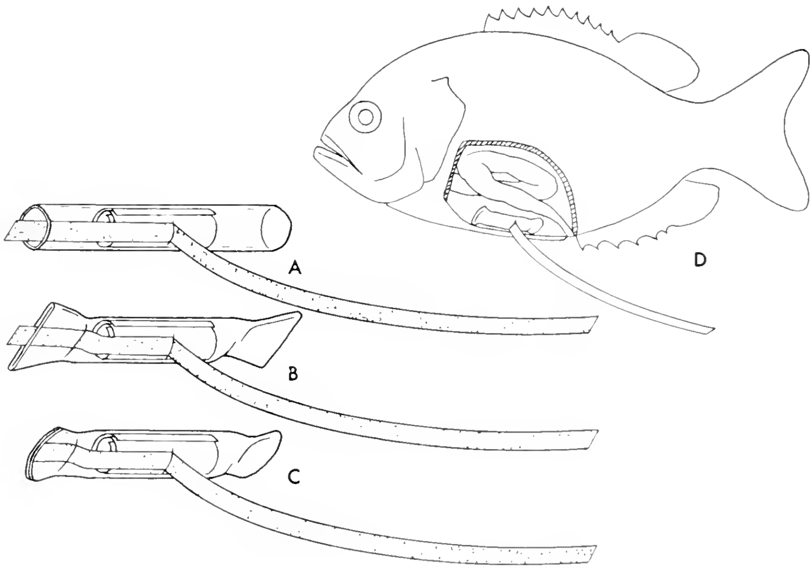

FIGURE 1—Internal capsule fish tag. A—25-mm section of neoprene tubing with streamer and message inserted. B—capsule with sealed ends. C—trimmed, completed tag. D—tag in exposed view of rock bass coelom.

quent dissection showed that some visceral adhesions had begun in the vicinity of the capsule.

—Robert W. Topp, Department of Fishes, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts 02138, December 1966.

A NEW HIGH-SPEED TAGGING DEVICE

A new way of applying external tags recently came to my attention. Originally developed for the textile industry, the tags are now available for fishery investigations.[1] Preliminary studies indicated actual or potential advantages over certain conventional tagging systems. This note describes the applicator, tags, methods of application, and preliminary observations.

A series of plastic tags is inserted into a slot in the applicator (Figure 1). The applicator needle is then inserted into the fish at the desired tag site. Compression of the applicator grip activates a spring-loaded piston which drives the T-bar end of the tag through the hollow, slotted needle. In this action the bar of the T is driven lengthwise through the needle, while the monofilament passes freely along the slot. As the needle is withdrawn the bar catches and turns perpendicular to the path of the needle. This turning prevents the tag from

[1] Applicator and tags are available from Floy Tag and Manufacturing Inc., 2909 N.E. Blakeley Street, Seattle, Washington 98105.

pulling out. The next tag is drawn into position when pressure on the applicator grip is released.

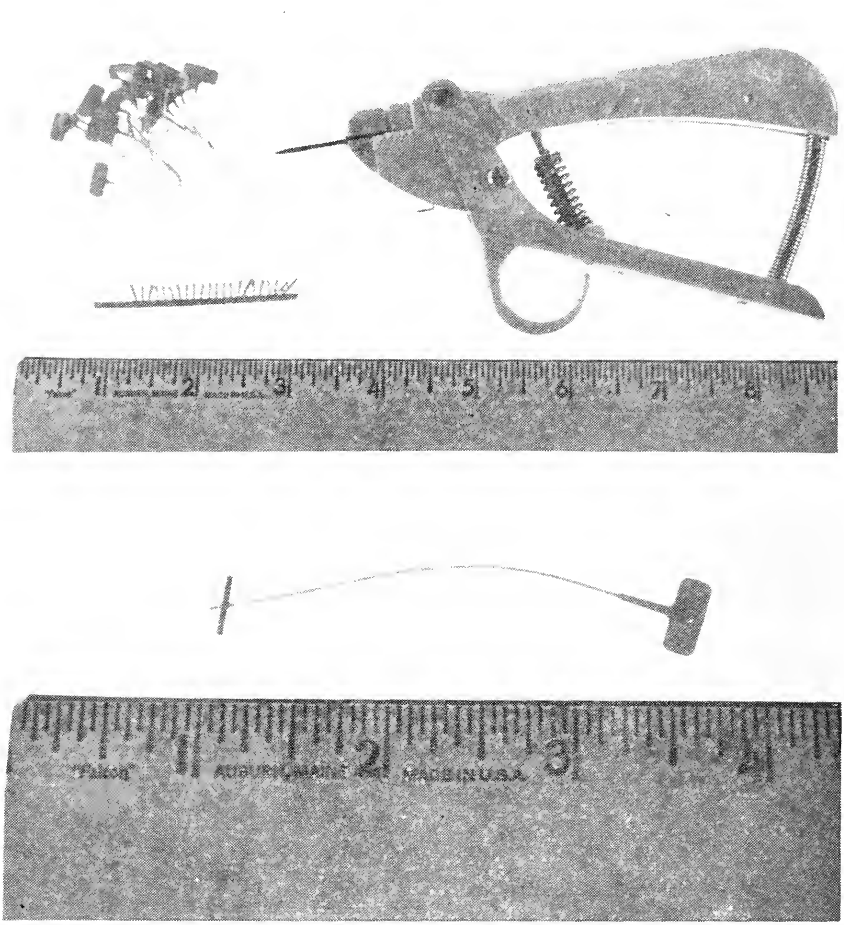

FIGURE 1—Upper: Applicator and series of tags, moulded to the header. Lower: A single tag.

About 24 rainbow trout (*Salmo gairdnerii*) were tagged at two sites (Figure 2): (i) through the dorsal musculature near the dorsal fin and (ii) in the flesh under the dorsal fin. When inserted near the dorsal fin, the needle was angled anteriorly to emerge near the origin of the dorsal fin; the trailing tag body and pennant then held the bar snugly against the skin. When inserted under the dorsal fin, the needle was placed so that the neural spines and dorsal fin interneurals helped maintain the 90° attitude of the bar. Here insertion of the needle slightly deeper than the intended implant point, followed by withdrawal before compression of the grip, allowed easier clearance of the bar from the needle than when inserted less deeply, and freer return of the bar to the 90° attitude.

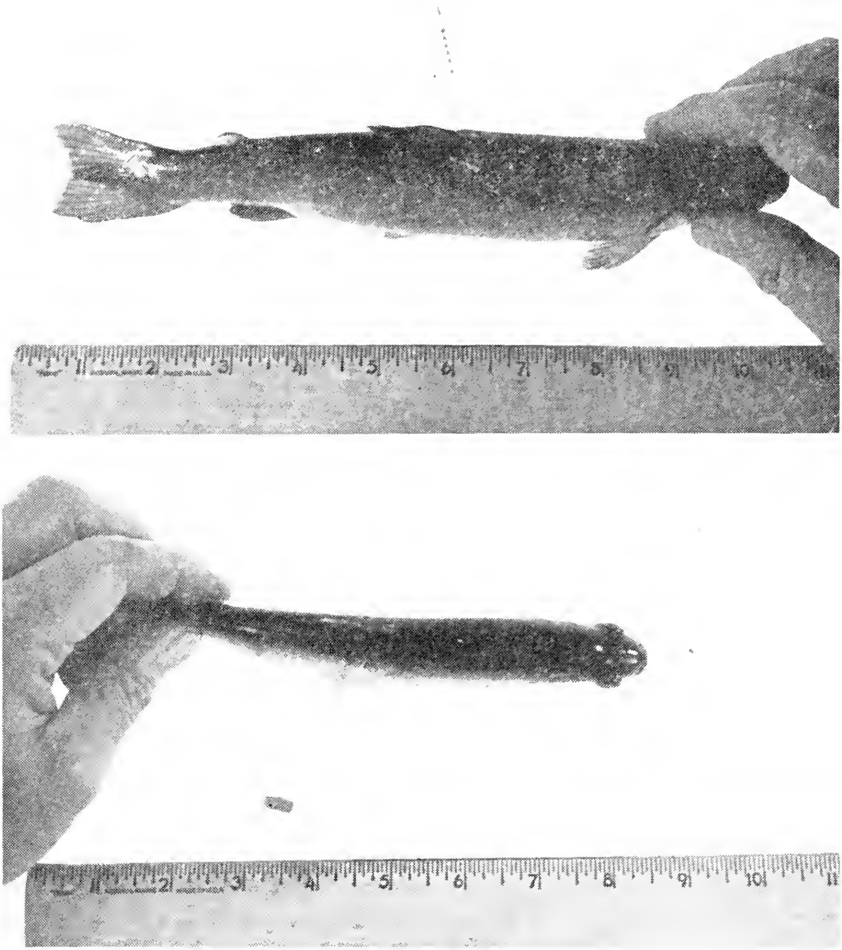

FIGURE 2—Upper: Rainbow trout tagged through the dorsal musculature anterior to the dorsal fin. Lower: Rainbow trout with tag implanted under the dorsal fin.

The rectangular shape of the pennant suggested that the tag might flutter and eventually pull out. Accordingly, tagged fish were placed for observation in a lighted glass flume in which water velocity was 4 feet per second. At this velocity the tag did not flutter, possibly due to the stiffness of the monofilament.

In these tests tag retention was not studied, since the fish were to be sacrificed for other purposes. However, six fish which were still alive after 3 months had retained their tags. A tagging rate of 50 fish per minute was possible. The sample tags were available in several colors, moulded in series up to 100. Colored "spaghetti" with labeling was added to some of these. The tags used were 2 inches long, but others from 1 to 5 inches are available. In some cases the pennant was trimmed to alter its shape, but this can also be accomplished by altering the tag mold.—*Kenneth N. Thorson, Bureau of Commercial Fisheries, Biological Laboratory, Seattle, Washington, March 1967.*

FIRST RECORDED XANTHIC SARGO, *ANISOTREMUS DAVIDSONII* (STEINDACHNER), FROM THE SALTON SEA, CALIFORNIA

On March 25, 1965, the first xanthic sargo reported from the Salton Sea was taken by an unknown angler fishing from the jetty at Bombay Marina. Mr. E. R. (Red) Bringle, owner of the marina, obtained the fish, froze it, and gave it to me several days after capture.

At that time no melanic pigmentation was evident. The general body coloration merged from light gold dorsally to silver laterally and ventrally. The fins had a golden hue tipped with silver. The eyes appeared to be encircled by an erythristic band. After this cursory examination, the fish was taken to Scripps Institution of Oceanography, La Jolla, California, where it was examined by Joseph F. Copp of the Marine Vertebrates Laboratory.

Copp reported that the fish measured 247 mm SL, and weighed 550 g frozen. While transferring the specimen from formalin to isopropyl alcohol, he observed a liberal sprinkling of black flecks both dorsally and laterally. Either the melanic pigmentation had been overlooked previously, or the process of preservation unveiled its presence.

Since 1960, thousands of Salton Sea sargo have been observed by fisheries workers during creel censuses and netting surveys. The large population of sargo in the Sea originated from an introduction of 65 fish from the Gulf of California on March 31, 1951 (Walker, 1961). Walker (pers. commun., 1965) mentioned that he knew of no xanthic sargo collected from the Gulf. However, xanthic color variations of sargo have been found in California Pacific coastal waters (Table 1).

TABLE 1

Records of Xanthic Sargo, *Anisotremus davidsonii*, from California Coastal Waters

Collection site	Year	Deposited with	Accession number
Vicinity of Oceanside	1953	Scripps Institution of Oceanography	SIO H53-181-44A
Santa Monica Pier	1957	Los Angeles County Museum	
San Pedro	1958	Marineland of the Pacific	MLP 58-22
San Pedro	1958	Marineland of the Pacific	MLP 58-22
Santa Monica Bay	1958	Marineland of the Pacific	MLP 58-51
Surf at Castle Rock	1959	Marineland of the Pacific	MLP 59-18
La Jolla	1962	Scripps Institution of Oceanography	SIO 62-246-44A

W. I. Follett (pers. commun., 1965) informed me of a large xanthic sargo that had recently been held in the Steinhart Aquarium.

The Salton Sea specimen is now in the collection of the Scripps Institution of Oceanography at La Jolla (SIO 65-544-44A).

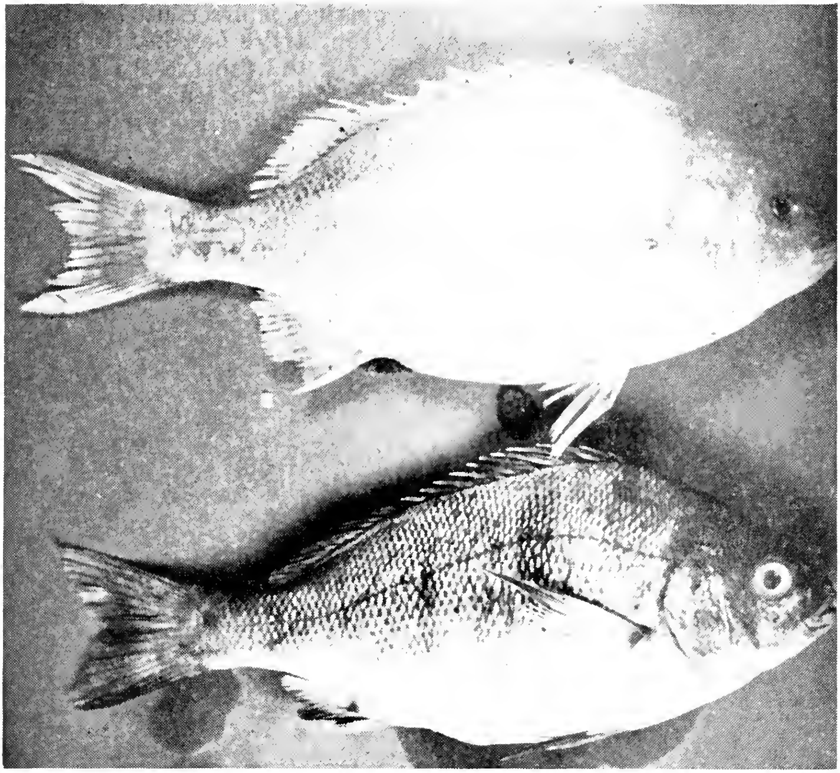

FIGURE 1—Comparison of xanthic sargo, *Anisotremus davidsonii,* from the Salton Sea (upper) with sargo of normal coloration. *Photograph by the author,* April 1965.

REFERENCE

Walker, Boyd W. 1961. The ecology of the Salton Sea, California, in relation to the sport fishery. Calif. Dept. Fish and Game, Fish Bull., (113) : 204 p.

—*Robert G. Hulquist, Inland Fisheries, Region 5, California Department of Fish and Game, February 1967.*

A HEAVY INFESTATION OF THE THREADFIN SHAD, *DOROSOMA PETENENSE,* BY THE YELLOW GRUB, *CLINOSTOMUM MARGINATUM,* IN EL CAPITAN RESERVOIR, SAN DIEGO COUNTY, CALIFORNIA

Threadfin shad collected at El Capitan Reservoir in the summer of 1964 were heavily infested with metacercarial cysts of *Clinostomum* *marginatum* (Rudolphi, 1819), a common digenetic trematode of fishes. A literature review revealed that the threadfin shad is a new host for this parasite (Miller, 1966).

The life cycle of *Clinostomum marginatum* is described by Hunter and Hunter (1935). The great blue heron, *Ardea herodias*, is the definitive host. Snails of the genus *Helisoma* and fish are the first and second intermediate hosts, respectively. *Helisoma tenue* is the only species of the genus present in El Capitan and is the probable first intermediate host.

El Capitan Reservoir is a water supply reservoir located 7 miles east of Lakeside at an elevation of 553 feet. The mean surface acreage in 1964 was 330 and the maximum and minimum depth at the gauge was 82 and 79 feet, respectively. The reservoir is turbid and steepsided, and submergent and emergent aquatic vegetation is not abundant. Several great blue herons were observed in residence during the summer of 1964. Threadfin shad were collected with a gill net (1.5-inch stretch measure) and an 80-foot seine ($\frac{3}{4}$-inch stretch measure) on August 8 and 12, 1964. Two size groups were evident and a subsample of each was measured and examined. Sagittal sections were made and methodically dissected to find metacercariae.

The cysts were tallied according to their occurrence in three major body areas of the fish. Of 26 fish 2.0 to 4.9 inches TL, 4 contained a total of 6 cysts in the peritoneal cavity, 2 had a total of 3 cysts in the musculature, and none were found with cysts in the gills and head region. Of 40 fish 5.0 to 7.9 inches TL, 33 contained a total of 160 cysts in the peritoneal cavity, 40 had a total of 551 cysts in the musculature, and 28 had a total of 88 cysts in the gills and head region. In summary, cysts were found in all fish over 5.0 inches, while only 19.2% of the fish less than 5.0 inches were infested.

The mean number of cysts per fish in the larger shad was 19.9 (range 1–72), compared with 0.55 (range 0–3) in the smaller shad. A plot of number of cysts on fish size was found to be curvilinear. The correlation coefficient of the log-log transformation was highly significant ($r = 0.8380$; $r_{.01,\ 64\ d.f.} = 0.3198$). This indicates that the severity of infestation is related to the size or age of the fish. This relationship has been demonstrated for a yellow grub infestation of yellow perch, *Perca flavescens* (Elliot and Russert, 1949).

The metacercarial burden in the larger shad is very high relative to that of other potential fish hosts observed at El Capitan Reservoir. Cursory examination of over 100 walleye, *Stizostedion vitreum vitreum*, revealed only three cysts in two fish. The low incidence of *C. marginatum* in walleye and other warmwater fishes at El Capitan indicates that the heavy infestation of shad may be related to environmental or behavioral factors which favor the penetration and development of the parasite in this species.

All threadfin shad examined were in good condition and none appeared emaciated or debilitated from the infestation. Elliot and Russert (1949) found no correlation between numbers of *C. marginatum* and condition factors of yellow perch.

Andrew Olsen of San Diego State College and T. W. Fisher of the University of California at Riverside identified the specimens. William Perrin assisted with data collection and Arlo Fast with data analyses.

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Elliot, A. M., and L. R. Russert. 1949. Some condition characteristics of a yellow perch population heavily parasitized by *Clinostomum marginatum*. Jour. Parasit., 35 (2) : 183–190.

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—*Lee W. Miller, Inland Fisheries Branch, California Department of Fish and Game, February 1967.*

IDENTIFICATION OF *COROPHIUM* FROM THE SACRAMENTO–SAN JOAQUIN DELTA

During an extensive survey of zoobenthos in the Sacramento-San Joaquin Delta in California, Charles R. Hazel of the California Department of Fish and Game identified two species of *Corophium*: *Corophium spinicorne* and *Corophium stimpsoni*. Both species are abundant and important food for bottom-feeding fishes in the Delta. *C. spinicorne* is a tube-dweller found on solid substrate, while *C. stimpsoni* is abundant in fine or a mixture of fine and medium sand (Hazel and Kelley, 1966).

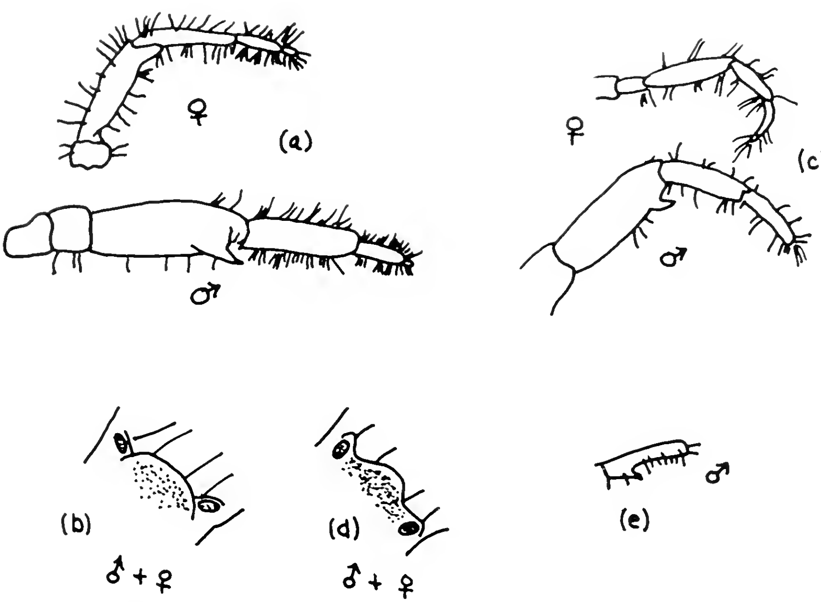

FIGURE 1—Antennae and head of *Corophium spinicorne* (a and b) and *Corophium stimpsoni* (c, d, and e).

It is important for these two species to be correctly identified in future work in the Delta and to that end I have composed the following simple key:

A. Segments of the urosome separate.

B. Setae on antennae profuse (Figure 1a).
Front margin of head smooth, rounded, convex, with no rostrum and not protruding forward (Figure 1b).
No spine on first peduncular joint of first antennae of males.
—*Corophium spinicorne*

BB. Setae on antennae common but not profuse (Figure 1c).
Front margin of head on both sexes protruding forward and evenly rounded but without distinct rostrum (Figure 1d).
Spine on inside of first peduncular joint of first antennae of males (Figure 1e).
—*Corophium stimpsoni*

AA. Segments of the urosome fused into a single plate.
C. atcherusicum
C. insidiosum
C. brevis
C. oaklandense

REFERENCES

Hazel, C. R., and D. W. Kelley. 1966. Zoobenthos of the Sacramento-San Joaquin Delta, p. 113–133. *In* D. W. Kelley [compiler] Ecological studies of the Sacramento-San Joaquin estuary. Part 1. Calif. Dept. Fish and Game, Fish Bull. 133.

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———. 1949. The amphipod genus *Corophium* on the West Coast of America. Jour. Wash. Acad. Sci., 39 (2) : 66–82.

—*D. W. Kelley, Delta Fish and Wildlife Study, California Department of Fish and Game, April 1967.*

NORTHERN RANGE EXTENSION OF THE GIANT SEA BASS, *STEREOLEPIS GIGAS* AYRES

On July 22, 1966, a small specimen of giant sea bass was caught by a sport fisherman who was trolling for salmon in the entrance to Humboldt Bay, California (lat. 40° 48′ N., long. 124° 11′ W.). The 15½-pound specimen was weighed by John Hanlon, a Department of Fish and Game employee who was sampling the catches of sport salmon fishermen. The specimen's head was obtained for positive identification.

The previously published range of giant sea bass was from San Francisco Bay to and into the Gulf of California (Ayres, 1859; Roedel, 1953). It appears to be rare off central California but relatively common off southern California and Baja California. In his original description of the genus and species Ayres states "Two specimens have been brought into the market, having been taken in the Bay of San Francisco, one in 1857, the other in 1859. The former measured five feet, eight inches in length, with a weight of one hundred and eightyseven pounds; the latter was seven feet long, and weighed three hundred and sixty pounds. They were evidently stragglers in our waters. There is reason to believe that below Point Conception they are found in some numbers, becoming perhaps common on the coast of Lower California."

W. I. Follett of the California Academy of Sciences (pers. commun.) reports the most recent northern occurrence as September 11, 1960, off China Camp in San Pablo Bay, the northern portion of San Francisco Bay. Follett also states that on the wall of Quan's Resort, China Camp, there is a picture of a 77¾ pound specimen taken nearby on October 10, 1937.

The Humboldt Bay specimen extends the range northward 2° 48′ or about 193 land miles.

Otoliths of the Humboldt Bay specimen were examined by John Fitch, California Department of Fish and Game; they showed five winter rings. Based upon age and head length (236 mm), the specimen was underweight in comparison with other records. Fitch (pers. commun.) reports small giant sea bass 194, 235, and 237 mm head length (4, 5, and 6 years old) to weigh 17, 24, and 25 pounds, respectively.

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Roedel, Phil M. 1953. Common ocean fishes of the California coast. Calif. Dept. Fish and Game, Fish Bull., (91) : 184 p.

—*L. B. Boydstun, Marine Resources Branch, California Department of Fish and Game, October 1966.*

A LONGFIN SANDDAB, *CITHARICHTHYS XANTHOSTIGMA*, AND A SKILFISH, *ERILEPIS ZONIFER*, TAKEN IN MONTEREY BAY

A longfin sanddab, 9.6 inches long, was discovered in an otter trawl catch of English sole, *Parophrys vetulus*, made on the bottom at a depth of 42 fathoms (252 feet) SSW of Pt. Santa Cruz, Monterey Bay, on February 24, 1967. The range for this sanddab is listed as Magdalena Bay, Baja California, to Pt. Conception, California; the maximum length is noted as 10 inches (Miller, Gotshall, and Nitsos, 1965). This capture extends the range for this fish about 170 nautical miles northward. Jack Carmenita, marketman at General Fish Corporation, Monterey, noted the unusual fish and saved it for identification. The catch was made in a trawl operated from the dragger *Anthony Boy*, Natale Caronia, Captain.

Sanddabs may be separated from other flatfishes by their blind-side ventral fin, which is located on the ridge of the abdomen. The longfin sanddab is distinguished from other sanddabs by the eyed-side pectoral fin, which is longer than the head.

A skilfish, 30.6 inches long, was taken with a commercial setline for sablefish, *Anoplopoma fimbria*, fished on the bottom at a depth of 220 fathoms (1,320 feet) west of Moss Landing, California, February 9, 1967. Jim Esaki, marketman at Regal Seafoods Company, Monterey, selected this uncommon fish from a catch of sablefish made by Captain Nash Favalora, of the vessel *West Wind*.

Previously, only four skilfish have been reported from California. The last report (Phillips, 1966) includes a photograph of a specimen, 17.8 inches long, which portrays the characteristic juvenile coloration of whitish blotches on a rather black background. These light blotches are only faintly evident in this recent 30.6-inch specimen. In larger individuals, the color of the body becomes uniformly blackened. This species attains a length of 6 feet and a weight of 200 pounds.

The skilfish is related to the sablefish, from which it may be separated in that the first (spinous) dorsal fin is set in a shallow groove, and the space between the first and second dorsal fins is less than the width of the orbit. In sablefish, the dorsal fin groove is not present and the dorsal fin interspace is several times the width of the orbit.

REFERENCES

Miller, Daniel J., Dan Gotshall, and Richard Nitsos. 1965. A field guide to some common ocean sport fishes of California. (2nd rev., Parts I & II comb.). Calif. Dept. Fish and Game, 87 p.

Phillips, J. B. 1966. Skilfish, *Erilepis zonifer* (Lockington), in Californian and Pacific Northwest waters. Calif. Fish and Game 52 (3) : 151–156.

—*J. B. Phillips, Marine Resources Operations, California Department of Fish and Game, March 1967.*

THE TAPERTAIL RIBBONFISH (*TRACHIPTERUS FUKUZAKII* FITCH) ADDED TO THE MARINE FAUNA OF CALIFORNIA

On February 22, 1967, Jamie Simon, Los Angeles, picked up a large ribbonfish that he observed floating near the south jetty in the entrance channel to Alamitos Bay, California. He took the fish to Robert J. Lavenberg, Assistant Curator of Fishes, Los Angeles County Museum of Natural History, who loaned it to me a few days later. I identified it as a mature female *Trachipterus fukuzakii*, the first of the species from California.

It was 1,120 mm (44 inches) long to where a portion of the tail was missing (perhaps 100 to 150 mm), and it weighed 1,350 g (3 pounds). Its distended ovaries contained numerous fully-developed, translucent eggs, and smaller sized ova were intermixed throughout. Seven winter annuli could be discerned on its otoliths (sagittae). The stomach of this fish was empty.

At the time *T. fukuzakii* was described (Fitch, 1964), only eight individuals were available for study, but since then I have examined five additional specimens, including the present one (Table 1). Four of the five were large adults, exceeding 1,000 mm each, but one, in the Scripps Institution of Oceanography collections (SIO 59-246), at 310 mm SL is the smallest tapertail ribbonfish known. The four largest individuals were females, but the sex of the 310-mm specimen could not be determined. The stomachs of two contained recognizable food items: (i) a small unidentifiable squid 37 mm mantle length, and 5 euphausiids, and (ii) seven lanternfishes (5 *Triphoturus mexicanus* and 2 *Stenobrachius leucopsarus*). The poor condition of several of the specimens precluded detailed measurements or accurate counts (Table 1).

TABLE 1

Selected Measurements, Counts, and other Data on Five *Trachipterus fukuzakii* (Standard length in mm, other lengths expressed as per mille of SL)

	1	2	3	4	5
Measurements					
Standard length	310	>1120	1243	>1300	1425
Head length	132	--	111	--	137
Snout to anus	-	--	434	--	523
Counts					
Dorsal rays (total)	153		172	--	156
Dorsal rays to vertical of anus	65	71	75	--	67
Pectoral rays	12	11	12	-	11
Ventral rays	5	--	--	--	--
Gill rakers	3+7	3+9	4+9	--	3+8
Vital statistics					
Sex	--	♂	♂	♀	♀
Weight (grams)		1350	2090	4090	4480
Age		7	--	--	11
Disposition	SIO 59-246	LACM 8977-1	LACM	discard	Cabrillo Bch. Mus.

Collection data

1. March 22, 1959; 30 miles SE of Altata, Sinaloa, Mexico; found on deck of seiner *Santa Helena* after set for yellowfin tuna.
2. February 22, 1967; floating dead ner south jetty at entrance to Alamitos Bay, California; Jamie Simon, coll.
3. July 1966; 18–20 miles W of San Pablo, Baja California; caught in nighttime set for tuna by seiner *Beverly Lynn*; Richard Chikami, coll.
4. July 22, 1966; caught with bluefin tuna by seiner *Southern Queen* off San Hipolito Point, Baja California; broken remains salvaged by personnel from Inter-American Tropical Tuna Commission.
5. July 1966; caught with bluefin tuna by seiner *Determined* off San Hipolito Point; donated to Cabrillo Beach Museum, San Pedro, by crew member Jack Shundo.

REFERENCE

Fitch, John E. 1964. The ribbonfishes (family Trachipteridae) of the eastern Pacific Ocean, with a description of a new species. Calif. Fish and Game, 50 (4): 228–240.

—*John E. Fitch, Marine Resources Operations, California Department of Fish and Game, May 1967.*

AN OCCURRENCE OF A CHUM SALMON, *ONCORHYNCHUS KETA* (WALBAUM), IN THE CALIFORNIA TROLL FISHERY[1]

The geographical range for chum salmon is often given as northern California to the Bering Sea and southward from there to Japan. It is quite common along the north Pacific Coast, while in the Bering Sea north of Bristol Bay, Alaska, it is the most abundant species of Pacific salmon (Mattson, 1962). It is also found in some streams tributary to the Arctic Ocean.

Reports of chum salmon in California waters are few. Chums have been reported in the San Lorenzo River, Santa Cruz County (Scofield,

[1] Submitted for publication November 1966.

1916), and a chum salmon was taken by a purse seiner off Del Mar, California (Messersmith, 1965). A very small run of chums has been reported for the Sacramento River system (Hallock and Fry, 1967). The authors estimated numbers by three methods, one of which gave an average annual run between 34 and 210 fish for the period 1951 through 1958. A few chums have been reported since that time, including two males at Nimbus Hatchery during the 1966–67 season. I have no other details. I am unable to find any reference to chum salmon in the California troll fishery.

On August 21, 1966, Gaspar Aliotti of the troller *Marianne A* caught a chum salmon while trolling about 3½ miles west of Tomales Point, California (lat. 38° 15′ N., long. 123° 4′ W.). It was taken within 30 feet of the surface, using Pacific herring bait, and was delivered to The Tides at Bodega Bay weighing 7½ pounds dressed head on and measuring 69 cm (FL). Ben Salvon, a California Department of Fish and Game port sampler, brought it to my attention. The fisherman reported it to be a male and this observation was supported by the presence of canine-like teeth characteristic of breeding males of this species. Its coloration was a blackish yellow-green on the back and sides, with a faint hint of strawberry low on the sides, which, along with the canine teeth, would indicate the onset of breeding maturity.

Positive identification by California Department of Fish and Game biologists was confirmed with scale examination by Phillip Swartzell of the department.

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—*Paul W. Wild, Marine Resources Branch, California Department of Fish and Game, November 1966.*

BOOK REVIEWS

The Sea of Cortez

By Ray Cannon and the Sunset Editors; Lane Magazine & Book Company, Menlo Park, Calif., 1966; 284 p., profusely illustrated, in color and black-and-white. $11.75.

Baja California and the Sea of Cortez (Gulf of California) cradled within the 600-mile reach of the "Baja" peninsula is little known to most "Norte Americanas" except for a relatively few fishermen, adventurous motorists, and yachtsmen. Although this land lies directly to the south of the most populous state in the United States, its tortuous roads have repelled all but the more adventurous travelers.

The Sea of Cortez, with lavish use of color and black-and-white photographs, tells of the Gulf of California and the land which surrounds it; its history, its people, its wildlife, and marine life.

The "Baja" peninsula and mainland coast bordering the Gulf of California are divided into twelve regions in the book and each region is described in detail. The only mention of the Pacific side of the peninsula is of the Magdalena Bay area. Much of the book relates to personal experiences of Ray Cannon. The fact that he is an avid sport fisherman is quite evident as a large portion of the narrative is about the fish found in the Gulf and the sport fishing to be enjoyed there.

Included in the book are detailed information on how to get there, accommodations, small boat cruising, and just about everything a traveler to this area needs to know. For fishermen, there is a section on angling methods, and gear, and an illustrated list of most fish likely to be encountered in the Gulf. Unlike many books of this type, the nomenclature in the list of fishes is accurate and fish illustrations are well done. The book is concluded by an excellent bibliography which should prove a valuable aid for anyone doing research on the area.

All in all, this is an excellent book and should find wide acceptance by those interested in this wild and fascinating land.—*Melvyn W. Odemar.*

Exploring Pacific Coast Tide Pools

By Ernest Braun and Vinson Brown; Naturegraph Company, Healdsburg, California, 1966; 56 p., 40 color pictures + line drawings. Paper $1.95, cloth $3.50.

This book's avowed intent is "to create a feeling of oneness and rapport with the life of our rocky shores." To this end, the often employed "biblical tone" and poetic license are well used. However, this rhetoric tends to mask the factual information, and the book's usefulness as a scientific work is greatly lessened.

Newcomers to the ocean's beauty will undoubtedly overlook the many inaccuracies and find this booklet more than acceptable. The advanced lay-observer, having already discovered the sea and looking for a not-too-technical text to increase his knowledge, will be disappointed in the inaccurate colors and artistic mode of the 40 plates. He will be further distracted by the errors in the cross referencing of text to photographs and text to the scientific listing of animals and plants. Students of oceanology will find this book of limited aid, since several appreciably more accurate texts are readily available.—*Charles H. Turner.*

Polychaeta Myzostomidae and Sedentaria of Antarctica

By Olga Hartman; American Geophysical Union, Washington, D.C., 1966; ix + 158 p., illustrated. $10.

The work begun by Dr. Hartman in volume 3 of this series (Polychaeta Errantia of Antarctica, 1964) is completed in this volume. All myzostomids (small aberrant polychaetes ordinarily found as ecto- or endoparasites of crinoid or ophiuroid echinoderms) and sedentary polychaetes known to exist in Antarctic or Subantarctic regions are listed. A brief diagnosis of each species is accompanied by a complete synomony, an adequate illustration, and a statement concerning distribution. Most helpful are the generic keys included with each family group.

A summary of zoogeographic considerations and five charts characterizing the distributions of the 34 most frequently collected sedentary and errant species make this book an invaluable aid to the Antarctic polychaete worker. To the nonspecialist, interested only in identifying polychaetes to family (or possibly to genus), the wealth of line drawings renders this book very useful. My only complaint is the high price of this volume, which may well preclude its purchase by amateurs.—*Diane Robbins.*

Water and Water Use Terminology

By J. O. Veatch and C. R. Humphrys; Thomas Printing and Publishing Co. Ltd., Kaukauna, Wisconsin, 1966; xvi + 375 + 6 p., photos and black-and-white illustrations. $12.95.

The title of this book implies that it is a comprehensive glossary of terms used in the many disciplines associated with water and its use. Actually, its scope is very narrow. Its definitions are largely limited to freshwater lakes, ponds, and reservoirs, with special attention given to the terminology of lake recreational development and use. Little space is given to biological terms.

Definitions of 1,109 terms are presented, many of which are either midwestern localisms or widely used colloquialisms. The authors have also coined several new words. For example, *lacology* " … is the study of lakes, ponds, and all other lentic water bodies … ". And, *purgatorial reliction* is, "a proposed term for a lake bed that has been recently exposed by recession of a shoreline and whose natural fate is uncertain, that is whether it is destined to remain land— or revert to a water surface". The many photos and illustrations are excellent, as is the format and printing.

Many of the definitions are too wordy, especially for terms that are seldom used or so commonplace that their meaning is already well known. A few definitions were droll; e.g., "*public access* implies the right of egress inasmuch as one must also leave a lake after having gained access".

This book is a worthwhile supplement to the standard glossaries that cover the nomenclature of the various sciences that deal with water. A copy probably should be available in every natural resources library for occasional reference.—*George W. McCammon.*

Teaching Kids to Shoot

By Henry M. Stebbins; Stackpole Books, Harrisburg, Pa., 1966; 96 p., illustrated. $2.95.

The objective of this book is to aid the prospective instructor in the task of teaching youngsters to shoot. It does an excellent job of attaining this objective. The basic information and gun data are up to date. The instruction methods are sound, and stress safety. The book is written simply, so that it can be enjoyed by a young student as well as by the adult instructor.

I was especially pleased to find that the author does not reject the parent as an instructor of his children.

Anyone planning to teach his own or other children the safe and skillful use of firearms will find this book useful.—*James D. Stokes.*

Hunting with Bow and Arrow

By George Laycock and Erwin Bauer; Arco Publishing Company, Inc., New York, 1965; 111 p., profusely illustrated with photos. $2.50.

This is a remarkably thorough book on hunting with bow and arrow, covering the subject with solid information which should be useful to a beginner or an expert. The authors explain what equipment is needed for present-day hunting, and how to select and judge it. They give complete instructions on how to shoot well, accurately, and safely. All aspects of hunting are described, and various chapters outline sound techniques for bow hunting everything from elephants to fish.

In addition to advice and information on hunting, the authors have included chapters on the history of archery, practice techniques, the fun and game aspect of archery, and the crossbow.

Perhaps the best feature of the book is the abundance of high quality photographs which the authors use effectively to illustrate the points of their text.—*Jim Ruch.*

Modern ABC's of Bird Hunting

By Dave Harbour; Stackpole Books, Harrisburg, Pa., 1966; 191 p. $4.95.

As the name implies, this booklet presents to the reader basic elements of bird hunting. It does so in the style found in popular outdoor publications and as such makes for enjoyable and relaxed reading.

After first covering guns, ammunition, and dogs used in bird hunting, the author discusses the species of game birds and techniques used in their pursuit. Since knowledge of the habits and whereabouts of the game is the key to successful hunting, much of the remaining portion of the text covers this subject. It is done in an informative manner designed to impart knowledge to the would-be hunter whether he be a novice or experienced outdoorsman.

The section involving bird identification has its shortcomings. It is without illustrations and falls considerably short in providing the newly interested hunter with the essential knowhow of bird identification. In addition, the author attempts the impossible task of providing the reader with an "easy" means of locating key hunting areas where birds can be taken in the states and provinces of the United States and Canada. If the reader is led to believe that from such information he is now equipped to depart his urban home and find happy hunting grounds, he will find it is just not that easy.—*Howard R. Leach.*

Coping with Camp Cooking

By Mae Webb Stephens and George S. Wells; Stackpole Books, Harrisburg, Pa., 1966; 96 p. $2.95.

This book is designed primarily for the family which camps with tent or trailer and has available a camp stove, ice chest or refrigerator, and a simple assortment of cooking utensils. The authors, who have impressive qualifications as authorities on camp cooking, explain quite frankly the problems which are apt to plague the camp chef. Practical solutions are offered for many of these difficulties, such as the preparation of meals during inclement weather and coping with bees, bears, and other wildlife marauders. I looked in vain, however, for a paragraph describing the merits of a roll of paper towels, an indispensable item for solving minor problems in a camp kitchen.

The chapter on altitude as it affects cooking time will be of special value to those who plan to camp at high elevations in the Sierra or Rockies. An account of one author's attempt to boil a beef tongue at an altitude of 10,000 feet adds a note of humor to the discussion. Both novice and experienced cooks will appreciate the variety of camp-tested recipes offered for nourishing and hearty meals, as well as the suggestions for the fourth meal of the day, the snack which is served at the evening campfire. Even the weekend chef whose cooking activities are confined to the charcoal grill in the backyard will find this book to be well worth its modest cost.—*George H. Warner.*

Border-to-Border Camping Trips

Compiled by Glenn and Dale Rhodes; Stackpole Books, Harrisburg, Pa., 1966; 96 p., illustrated with diagrammatic maps. $2.95.

Happier Family Boating

By George S. Wells; Stackpole Books, Harrisburg, Pa., 1966; 94 p., black-and-white illustrations. $2.95.

The Complete Guide to Family Camping

By Bill Riviere; Doubleday & Company, Inc., New York, 1966; 224 p., illustrated with over 100 photographs and line drawings. $4.50.

An outdoorsman may inspect the attractive color photograph on the jacket of this book and conclude that the author does not qualify as a seasoned camper. The fly rod shown leaning against the tent with the reel in the sand, the camper holding a short–handled skillet over an open fire, and the lantern suspended precariously from the tent fly are indications of inexperience. However, the axiom "don't judge a book by its cover" applies here.

The Complete Guide to Family Camping is indeed a comprehensive source of information for campers. Author Bill Riviere is not only an authority on camping techniques and camping equipment, but he also has the ability to share his knowledge with the reader. Of special value to the novice camper is the author's appraisal of various items of camping gear, ranging from tents and trailers to ice chests and sleeping bags. From this evaluation it may be concluded that an investment in quality equipment pays off in terms of years of satisfactory service.

Chapters on planning the camping trip, setting up camp, and camp behavior contain appropriate guidelines for both tent and trailer campers. The author also offers practical recommendations for coping with a capricious Mother Nature and with a variety of wildlife neighbors in whose domain the camper is a trespasser. Even the old "pro" outdoorsman can pick up some useful ideas from this guide.

Bill Riviere has supplemented the descriptive material in his book with an excellent selection of photographs and drawings and I can only conclude that the publisher is responsible for the camping scene on the jacket.—*George H. Warner.*

Outdoor Photography

By Erwin Bauer; Outdoor Life—Harper & Row, New York, 1965; 141 p., illustrated. $3.95.

"Every outdoorsman can multiply his pleasure in the field by carrying a camera and making the best use of it." Bauer's words should include the biologist who can not only increase his pleasure but the value of his work with the proper use of a camera.

The reader is helped in the selection of the best type of camera for his use in taking photographs outdoors. This section is followed by fundamentals of photography, with tips on films and accessories. Composition of the outdoor photograph includes suggestions on recording outdoor trips, animals, and plants pictorially.

Although the field biologist may be concerned mainly with record shots, with a little additional effort he can produce interesting photographs that tell a story. The author, in commenting on pictures of fishermen with fish, mentions that it is not necessary that these be dull or routine ". . . try to catch that expression of genuine surprise, satisfaction, and pride on the angler's face."

A very brief section on aerial, underground, and underwater photography is included. The chapter "How to File Photographs" could have been deleted and replaced with information on techniques. The photographs, particularly of wildlife, are excellent. Bauer concludes with "Pictures by Pros", demonstrating what can be accomplished with proper use of a camera.

Those unfamiliar with the hobby of outdoor photography will find that the material and its presentation are such that the reading is easy, interesting, and worthwhile.—*J. A. St. Amant.*

Axelrod's Tropical Fish Book

By Herbert R. Axelrod; Arco Publishing Co., Inc., New York, 1965; 112 p., over 180 photographs. $2.50.

Axelrod's Tropical Fish Book is a condensed black-and-white version of "Exotic Tropical Fishes", by Axelrod et al., published in 1962.

Basic principles of holding tropical fish are presented. Setting up the aquarium is explained with photographs of equipment and aquatic plants. A major portion of the book deals with 12 families of tropical fishes, including 181 species illustrated with photographs. The finished aquarium section gives suggestions and photographic examples on how to arrange and decorate aquarium interiors.

An example of the text, wherein author Axelrod comments on the infamous piranha, follows: "This is one of the 'nasty' Piranha species which can inflict a very painful wound if allowed to do so. They make wonderful 'conversation pieces' but the aquarium in which they are kept should be always kept covered where children cannot get at it. The teeth are not always in plain evidence, but they are there, and they are sharp!"

Although some of the fish photographs are dark and lack detail, most are well presented. To demonstrate colors found in many tropicals, many of the black-and-white photographs could have been sacrificed for some color plates. Since the book is designed for the beginner, some discussion of fish foods and care of diseased fish should have been included.—*J. A. St. Amant.*

Quality of the Environment: An Economic Approach to Some Problems in Using Land, Water, and Air

By Orris C. Herfindahl and Allen V. Kneese; Johns Hopkins Press, Baltimore, 1965; viii + 96 p. $2.

The rapid growth of population and industry in the United States in the last 25 years has exceeded the growth of our abilities to cope effectively with the resultant pressures and problems brought to bear on our physical environment. The authors, authorities in the field of natural resource economics, point out that this inability is largely due to the failure of our politico-economic system in this field. On this note they proceed in separate chapters to analyze five germane problems of resource use existing in the United States today: water pollution, air pollution, the use of pesticides, the use of urban places, and the development of rural areas, including "wild" areas. Especially interesting is the comparison drawn between water and air pollution and the concept of dealing with air pollution problems on the basis of "air sheds", as we now think of water resources in terms of watersheds.

While the authors do not become overly technical, the role of economics in these problems is presented with sufficient clarity and detail for a noneconomist to understand. Although their primary concern is with economics, they are careful to show how it relates to the scientific and engineering aspects of these environmental quality problems. The underlying need for much greater amounts of research in all related disciplines is stressed. This is necessary so that sufficient facts will be available to allow society to make the best decisions where conflicts in resource use arise. In the concluding chapter the authors present a multidisciplinary, four-stage research strategy which they suggest should be applied toward an understanding and solution of the problems our environment faces.

For the noneconomist, this short book will add another important dimension to environmental use problems. For a concise, comprehensive, and up-to-date analysis of the environmental problems facing our society today, it is recommended for everyone.—*Stephen J. Nicola.*

A Field Guide to Shells of the Pacific Coast and Hawaii, Including the Gulf of California (Second Edition)

By Percy A. Morris; Houghton Mifflin Co., Boston, 1966; xxxvi + 297 p., illustrated with photographs. $4.95.

Before I make any other statement, let me point out that this field guide (second edition) is an excellent, well-illustrated, and helpful little volume on shelled mollusks of the Pacific Coast. Its potential usefulness so far outweighs its shortcomings, that I would not mention what I feel are drawbacks, except for the possibility of obtaining further improvement in future editions.

I would like to see a more representative (typical) selection of shells in future editions, as well as more meaningful habitat notes, and more exacting range (distribution) data.

Perhaps several dozen species that occur abundantly along our coast have not been mentioned, while close relatives that are rarely seen are given full treatment. In many cases this does not preclude an amateur collector making a generic determination, but I feel it is much better to have an illustration and discussion of a mollusk that is likely to be encountered than one that is not. The very first bivalve mentioned, *Solemya johnsoni*, is a good example. Clams of this genus are rather rare to begin with, but for every example of *Solemya johnsoni* in existence, I'll wager there are 100 or more of *Solemya panamensis.*

The habitat notes generally are misleading, erroneous, or meaningless. For example, *Trigoniocardia biangulata* is listed as being in "moderately shallow water" (p. 25), whereas *Ventricolaria fordi* (p. 26) is placed "well off shore", yet both species can be picked up by a skindiver on the same 30-second dive in 20 feet of water at Santa Catalina Island, one of the few places in California where both are relatively abundant. Most of the Pismo clam population is in the intertidal or shallow subtidal, yet they are listed here (p. 26) as being in "moderately shallow water" equivalent to "30 to about 80 feet" (p. xxiii). Habitat notes are a very good idea, but they are of little use if they are oversimplified or inaccurate. The situation can be easily remedied by applying (where known) such meaningful words and phrases as "parasitic on ________", "in soft mud", "undersides of cobbles and boulders", "exposed open coast", "bores in soft rocks", "nestles in pholad holes", and so on.

Finally, I would like to see more exact ranges given for the various species where such listings as "Mexico", "Baja California", "California", etc. now appear. Obviously, such a broad geographic "distributional boundary", sometimes involving two or three faunal provinces, can't be very helpful to anyone who wants to use the book to determine what his chances are of finding a particular shell at a particular locality—realizing of course that the mollusk has to live there in order to be found.

As with any work of this magnitude, there are a few obvious, and many not-so-obvious, reminders that gremlins have been busy (e.g., misspellings, printer's errors, etc.), but these do not detract from the book's usefulness. Assuming I counted accurately, West Coast shell enthusiasts will find that 177 bivalves, 212 gastropods, 11 chitons, and 1 scaphopod are discussed and illustrated for their area, while similar treatment is given for representative genera and species from Hawaii and the Gulf of California. Background and introductory chapters are especially worth reading, and several sections at the back of the book provide useful information.—*John E. Fitch.*

Raising Laboratory Animals: A Handbook for Biological and Behavioral Research

By James Silvan; The Natural History Press, Garden City, New York, 1966; xiv + 225 p., illustrated. $4.95.

Nature abhors a vacuum and, by analogy, if in the world of literature there exists a subject that has not been set in print some author will eventually fill the void. James Silvan seized an opportunity by writing a handbook on methods of collecting and keeping representatives of the animal kingdom.

The title, *Raising Laboratory Animals*, at first glance leads one to assume that this book deals with the usual laboratory animals: rabbits, guinea pigs, hamsters, rats, and mice. Alhtough each of these, with one exception, has a chapter devoted to sources of supply, housing, and care, the greater portion of the text covers a wide range of the animal kingdom. The animals discussed range from amoebas and other protozoans through hydras, planarians, nematodes, annelids, grasshoppers, crickets, termites, guppies, pigeons, and opossums. The notable exception is the rabbit.

The full title, *Raising Laboratory Animals: A Handbook for Biological and Behavioral Research*, is more descriptive and the last portion of the book gives a somewhat enlarged view that is actually a summary of some short experiments that might be performed in a high school laboratory.

There are many interesting accounts of the histories of the particular animals under discussion, and these are enhanced by their brevity. The care and feeding of the laboratory animals is well done and succinct. As a reference for the college instructor in first year biology who is desirous of maintaining a supply of teaching materials, this book would be helpful. However, Dr. Silvan is somewhat provincial in his list of sources of equipment and supplies, for the preponderance of scientific supply houses mentioned are on the east coast.

For the professional biologist there isn't very much of value within the pages of this handbook, but again it should be noted that it would be beneficial to a first year biology instructor in a college, and of even greater importance to a high school biology teacher.—*Merton N. Rosen.*

General Parasitology (Third Edition)

By V. A. Dogiel; revised and enlarged by Yu. I. Polyanski and E. M. Kheisin (transl. from the Russian); Academic Press Inc., New York and London, 1966; ix + 516 p., 228 figures. $16.50.

Often, works on general parasitology lean heavily in the direction of forms found in or on man or animals of economic importance to him.

This effort, while not shorting man or animals of economic importance, does provide relief with a generous treatment of forms ranging from those found in invertebrates (protozoa—polychaete worms—insects) to those in all classes of vertebrates.

The book is divided into four parts: Parasitism, Its Distribution and Origin; Adaptations in Structure and Life Cycles of Parasites; Parasite Fauna and Its Environment; and Host-Parasite Relations and the Problem of Species in Parasites.

Parasitologists who are mainly interested in biochemical and physiological approaches may feel that only a light touch was provided for their interests. This will not be a serious drawback for those interested in a more general approach to the subject.

This book does open up a rather extensive amount of work done by Russian parasitologists which previously was mostly unknown in English-speaking countries. Often this work includes work on fish parasites. This is an indication of the serious efforts being carried on in fish biology by the Russians.

The illustrations, all by N. G. Korabova, are uniformly good and a welcome relief from the often crudely drawn and reproduced originals provided by earlier workers.

Though translated from the Russian, it appears as if the original could have been in English. No small measure of credit for this must belong to Z. Kobata, the translator.

Academic Press, the publisher, is to be congratulated for turning out this handsome volume, which will be useful to all those interested in studying, teaching, or working in parasitology.—*Harold Wolf.*

Studies of Opisthobranchiate Mollusks of the Pacific Coast of North America

By Frank Mace MacFarland; California Academy of Sciences, San Francisco, 1966; Memoirs, vol. VI, xvii + 546 p.; 72 plates (29 in color). $17.50.

Who among us, having once viewed the delicate beauty of nudibranchs and tectibranchs (sea slugs), have not marveled at these brightly colored creatures and wondered as to their myriad variety. Our attraction to these lovely animals was shared, for some 40 years, by the late Dr. MacFarland, who, as Professor of Histology and related subjects at Stanford University, made detailed histological studies of opisthobranchs collected in nearby coastal waters. Throughout these studies he was aided by his wife, Olive Hornbrook MacFarland, who, with assistance from the California Academy of Sciences editorial board, has recently combined his various notes and drawings into this one impressive volume. It includes information about each species' anatomy, color, size, habits, and habitat. There are anatomical drawings of each species and color plates of many. Decisions regarding taxonomic revisions for the group are presented, also.

As noted in the book's preface, "It can not be expected that a posthumously published work such as this can be entirely satisfactory." For example, the author could not examine the final manuscript or proofs, the text could not be updated without possible modification of the author's original thoughts, and it was similarly impossible to evaluate properly and incorporate into this text the various nomenclatural changes which have occurred in the 15 years since Dr. MacFarland's demise. These chores have been wisely left for the current and future experts in this field.

A major value is that finally a comprehensive collection of opisthobranch information and references is available in one volume. Of special value are the detailed descriptions and drawings, which should greatly assist in resolving taxonomic and biological queries concerning these animals.

Limitations of the book's usefulness include the fact that some revisions (e.g., *Flabellina* to *Flabellinopsis*) are not well substantiated or explained in the text, and that some species which are described as new already are known from the works of others (e.g., *Phidiana nigra* MacFarland 1966 was described in 1962 by Lance as *Phidiana pugnax*). It might have been better if no attempt had been made to describe new species 10 to 15 years after work had been terminated on them.

In all, this volume does contain a wealth of knowledge and its publication should renew interest in and accelerate study of this group. Despite its shortcomings — (i) various unresolved problems in taxonomy and nomenclature, (ii) limited and outdated geographic and bathymetric range information, and (iii) the elapsed time between completion of the work (1955) and its publication— marine naturalists and biologists will find it a beautiful and useful addition to their reference library. Considering the comprehensive content, the number of plates and color prints, and its quality of publication, this volume is indeed modestly priced.

Of particular interest to the casual student and lay observer are the 29 color plates. The California Academy of Sciences has printed and bound several hundred copies of these (and their figure designations) separately, and these alone are well worth the modest charge of $3.50 a copy, if one cannot afford or has no use for the entire volume.—*Charles H. Turner.*

A Field Guide to Western Amphibians and Reptiles

By Robert C. Stebbins; Houghton Mifflin Co., Boston, 1966; xvi + 270 p., 39 plates, 290 drawings, 192 maps. $4.95.

At long-last a volume on the reptiles and amphibians of western North America has joined the popular Peterson Field Guides as No. 16 in the series. It is a most welcome addition, and will serve as a companion to Roger Conant's *A Field Guide to Reptiles and Amphibians* of eastern North America.

The new guide covers the more than 200 species of salamanders, frogs, toads, turtles, lizards, and snakes, as well as many subspecies, found west of the eastern boundaries of New Mexico, Colorado, Wyoming, Montana, and Saskatchewan north to the Arctic Circle.

Following an introduction, the book leads off with chapters on "Making Captures", "Caring for Captives", and "Field Study and Protection". Carefully condensed descriptions in the text point up major characters for identification and present significant features of habitat, range, and similar species. Identification keys lead to the illustrations on the plates singling out easily observed characteristics. The final chapter on amphibian eggs and larvae contains keys and many useful illustrations. The book concludes with a glossary, list of references, and distributional maps.

Almost all of the 39 plates, 24 in color, were illustrated from life. They are superbly executed, and the color reproductions are excellent.

Robert Stebbins, Professor of Zoology and Curator of Herpetology in the Museum of Vertebrate Zoology at the University of California, has successfully combined his considerable talents as herpetologist and illustrator to produce a complete, useful, and accurate guide.—*Leo Shapovalov*.

The California Wildlife Map Book

By Vinson Brown and David Hoover; Naturegraph Publishers, Healdsburg, Calif., 1967; 150 p., illustrated with over 650 black-and-white drawings and an 8-page color habitat map. $4.50 cloth; $2.95 paper.

The outdoorsman or hiker who has not seriously studied California's fauna and flora but is interested in identifying the kinds of animals and plants he encounters can find this book to be a useful guide to sight recognition. He may not always be sure of exact species identification, but he will at least have a fair idea of what he has seen.

As the authors say, the book is meant primarily "for the older youngster interested in nature". He or she is advised how to paint or otherwise color the drawings, though it is suggested that this be done from life or from good color illustrations.

Color habitat maps of the State are included in the book. Numbers under the illustration of each species of animal and plant tell the reader in which habitat it is to be found.—*Leo Shapovalov*.

Primary Productivity in Aquatic Environments

Edited by Charles R. Goldman; University of California Press, Berkeley, 1966; 464 p., illustrated. $7.

The first symposium of the International Biological Programme took place at Pallanza, Italy, April 26-May 1, 1965. Research authorities in the fields of limnology, oceanography, plant physiology, and biochemistry assembled from 12 nations to contribute to the symposium, the purpose of which was, " . . . to review the achievements in primary productivity research, as well as to discuss and formulate ideas for further exploration of the most promising areas of research." These specialists presented the latest results in primary productivity research with reference to both the marine and freshwater environments. This volume represents the proceedings of that symposium.

Contributed papers are present in six general categories: (i) The photosynthesis and adaptation of algae, (ii) Factors limiting the productivity of natural phytoplankton populations, (iii) Production and utilization of organic solutes by bacteria and phytoplankton, (iv) Productivity of higher aquatic plants and periphyton, (v) Primary productivity and standing crop, and (vi) Theoretical problems of primary productivity, light, and community structure.

Appropriately, the first paper, by G. Forti, discusses the photo-biochemical aspects of the photosynthetic process, the basis of productivity. Among the topics discussed are the overall reaction of photosynthesis, phosphorylation, the Hill reaction, the Emerson effect, and the electron transport system. This paper offers an excellent review of the subject in preparation for a better interpretation of the following presentations. A printing error in equation (1) is obvious. Adaptation of planktonic algae to environmental factors, particularly temperature and light intensity, and characteristics of light-synchronized algal populations are the subjects of three papers. An interesting discussion of describing the overall activity of a phytoplankton community by the activity structure concept is included in the paper submitted by C. J. Soeder. Assimilation rates, micronutrient limiting factors and their detection, and carbon-14 enrichment bioassays are the subjects of individual papers. Four presentations discuss the production and utilization of organic solutes by bacteria and phytoplankton. One particular paper by JU. I. Sorokin examines the role of chaemoautotrophic bacteria as a link between the products of anaerobiosis in bottom sediments and the productivity of the water mass.

Consideration of primary productivity is not restricted solely to bacteria and phytoplankton. Four papers detail results of recent inventigations concerning the productivity of higher aquatic plants and periphyton, with emphasis on the techniques and problems of estimating biomass measurements. Discussions under the general category of primary productivity and standing crop examine the relationships between algal biomass, cell size, and assimilation rates. The importance of phytonannoplankton in the overall assimilation of carbon is expounded. An informative article by C. S. Yentsch describes the apparent relationships between chlorophyll and phaeophytin, a nonphotosynthetic decomposition product, in the productivity of the marine euphotic zone.

The final category of presentations considers theoretical aspects of primary productivity and includes papers concerning diffusion uptake in cells, productivity and community structure, models of photosynthesis-depth curves, and others.

An abstract and useful, often extensive, list of references accompanies each paper. Three of the 27 symposium presentations are represented by an abstract only. The volume is written in a technical style, profusely illustrated with instructive graphs and charts, and indexed by subjects, waters, and organisms.—*Keith R. Anderson.*

Birds in Our Lives

Edited by Alfred Stefferud; U. S. Govt. Printing Office, Washington, D. C., 1966; xiii + 561 p., illustrated with 80 wash drawings and 372 photographs. $9.

Birds in Our Lives is the second in a series sponsored by the U. S. Bureau of Sport Fisheries and Wildlife. *Waterfowl Tomorrow* is the first. The basic theme is the relationship of birds to man. Under nine major topics, 61 authors discuss the role of birds in literature and art, hunting, recreation, habits of birds, misunderstandings related to certain species, falconry, husbandry, man's attempts to fly like birds, migration, the impact of man on birds, problem species related to commerce, overabundance of some species, and with impressive emphasis the necessity for intelligent management.

The majority of the authors are professional conservationists working for various institutions and conservation departments.

The photography is in black-and-white, and is excellent.

The book is comprehensible to anyone with a grasp of the English language. It would be an asset to a professional biologist's library, and certainly to a family library.—*Larry K. Puckett.*

The Motorboatman's Bible

By Mark Penzer; Doubleday & Company, Inc., New York, 1966; 122 p., illustrated with more than 125 drawings and photographs. $1.95 (paper).

The Motorboatman's Bible, written by the Associate Editor of *Motor Boating Magazine*, is intended to serve the neophyte boater as a guide to the buying, outfitting, maintenance, and operation of small motorboats. Contained in its 13 illustrated chapters are general discussions of motorboat types, power options, and accessory equipment which are designed to help familiarize the potential boat buyer with a part of the vast array of equipment available to him. A chapter titled "A Buying Approach" points up some of the factors the buyer should consider in selecting the boat best suited to his needs. Other chapters are devoted to state and federal equipment requirements, and the care and maintenance, safe operation, and recreational uses of motorboats. A brief section on knot tying, with step-by-step diagrams, is also included. The book's many black-and-white photographs serve best to illustrate pieces of boating equipment with which the novice may be unfamiliar. An adequate six-page index completes the volume.—*Paul M. Hubbell.*

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Notice is hereby given, pursuant to Sections 206, 207, and 208 of the Fish and Game Code, that the Fish and Game Commission shall meet on October 6, 1967, at 10 a.m., in Room 1138, New State Building, 107 S. Broadway, Los Angeles, California, to receive recommendations from its own officers and employees, from the Department of Fish and Game and other public agencies, from organizations of private citizens, and from any interested person as to what, if any, regulations should be made relating to fish, amphibia, and reptiles, or any species or subspecies thereof, for the 1968 sport fishing season.

Notice is hereby given, pursuant to Section 206 of the Fish and Game Code, that the Fish and Game Commission shall meet at 10 a.m. on November 3, 1967, in the State Building, 1350 Front Street, San Diego, California, for open public discussion of, and presentation of objections to, the proposals presented to the Commission in October and to publicly announce the regulations it proposes to make relating to fish, amphibia, and reptiles for the 1968 sport fishing season.

Notice is hereby given, in accordance with Section 206 of the Fish and Game Code, that the Fish and Game Commission shall meet on December 8, 1967, at 10 a.m., in the Main Floor Auditorium, Employment Building, 800 Capitol Mall, Sacramento, California, to hear and consider any objections to its determinations and proposed regulations in relation to fish, amphibia, and reptiles for the 1968 sport fishing season, such determinations and orders resulting from the hearings held on October 6 and November 3, 1967.

Fish and Game Commission
Monica O'Brien
Secretary to the Commission

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