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REARING BIGHORN LAMBS IN CAPTIVITY[1]

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INTRODUCTION

The rearing of wild animals within enclosures for the purpose of study and observation is often a desirable part of sound game management. When the enclosed habitat is not too artificial in relation to the natural environment of the animals, much information of value, that would be collected in the field only through chance or extreme luck, can be obtained.

When bighorn sheep (*Ovis canadensis*) are held in confinement for the purpose of collecting scientific data they should be under the direct care of one person, who is present most or all of the time. This person should be one who is interested in wildlife and wildlife problems to the extent that keeping a daily journal of the actions and mannerisms of the animals is an adventure rather than a chore. He should report, at his first opportunity, anything that appears to be detrimental to the health, safety, or welfare of his charges. It is highly important that he make daily effort to tame them to the extent that they can be handled without injury or fright. Tame animals simplify the tasks of obtaining information on weights, measurements, and dentition, making external examinations, and caring for the animals during sickness.

One of the major purposes of keeping fenced bighorn sheep at the Corn Creek Headquarters of the Desert Game Range, a national wildlife refuge near Las Vegas, Nevada, is to obtain information on lambing and young lambs. Since bighorn ewes in the wild are extremely wary while their lambs are young, the lambing observations and studies of young lambs at the Corn Creek Headquarters were needed to supplement binocular observations in the field.

The rearing of bighorn lambs in captivity is not new; however, little of the information has been recorded or published, so that a guide in the form of the findings of others is unavailable. In the absence of such data, the following information may be of value to those who would rear bighorn sheep for study purposes. This information has been compiled from work done at the Zoological Society of San Diego under the direction of Mrs. Belle J. Benchley, recently retired Executive Secretary, and Dr. Glen Crosbie, veterinarian; from work done with domestic sheep by the author and others; and from work done by refuge personnel and the author with Nelson bighorn sheep (*O. c. nelsoni*) at the Corn Creek Headquarters of the Desert Game Range.

Much of the information collected from the Corn Creek bighorn pasture resulted from the observations and help of Mr. and Mrs. Lloyd

[1] Submitted for publication December, 1954.

McKibbin, Mr. and Mrs. Jim Burnam, Mr. Jack Welling, Mr. and Mrs. Dean Rodman, and Mr. Duane Davidson, refuge personnel who lived at the Headquarters. Mrs. Benchley and Dr. Crosbie of the Zoological Society of San Diego opened their back files of information on bighorn sheep at the "Zoo," gave freely of their personal experiences, and critically read the manuscript. Dr. V. H. Fisher, Las Vegas veterinarian, made autopsies on lambs and Dr. E. R. Quortrup of the San Diego County Livestock Department contributed valued pathological studies of lamb remains.

CARE OF THE ANIMALS

The Enclosure

At the Corn Creek Headquarters it was found advisable to have a sheep pasture of sufficient size to be divided into smaller units. This was accomplished by fencing, with gates connecting the units. Such a pasture allows seasonal segregation of the sexes, which occurs in the wild, and in small herds eliminates the harassment a ram may give one or more ewes when no other rams on which he can expend surplus energy are present. Division of the pasture also permits rotation of units to check excessive grazing of any one portion of the pasture. The Corn Creek pasture started out as a small unit of less than one-quarter acre and was later enlarged to approximately three-quarter acre to gain access to native browses, furnish rough ground to keep the feet of the

FIGURE 1. Early stages of pasture development at Corn Creek Headquarters, showing fence construction. Ram in foreground is seven years of age and was captured when four months old.

FIGURE 2. Lambs brought from the wilds tame rapidly if handled often. This lamb has been in captivity less than one week.

animals trimmed to a normal shape, and permit fencing that would keep the ram and ewe separated during late pregnancy and while the lamb was young. Recently the pasture was enlarged by an additional two acres to enclose more native vegetation, rocky outcrops, and small caves.

Bighorn lambs up to five months of age caught in the wild tame down readily if kept in a small enclosure for a few days and handled often. Once tame, they become docile and make little or no effort to fight a fence in efforts to escape. These lambs form an ideal nucleus for a study herd.

Wild lambs obtained for the Corn Creek Headquarters have been kept for eight years behind a fence of hog wire seven feet high. For permanent construction and elimination of maintenance, it is recommended that six-foot chain-link fencing of a light weight, capped with a foot or two of hog wire, be used. Two-inch galvanized pipe posts set in concrete will last indefinitely, although pine or juniper posts of good size will serve for a number of years if creosoted well before setting in the ground.

If there were no shade in the desert, there would be very little diurnal animal life. Bighorn sheep under fence in desert areas must have shade from the heat of the summer sun. This can be provided by trees within the enclosure or by artificial means. If trees are present in the enclosure, the trunks should be protected from the butting and nibbling habits of the animals. A large, padded butting post may be installed for the rams.

During periods of adverse weather, shelter is also an important part of a bighorn enclosure. In the winter months, even the desert forms of sheep have a warm inner fleece, in addition to the outer coat of rough hair. This fleece is sufficient for warmth, provided the animals are protected from the penetrating chill of cold winter winds and do not become wet for considerable periods of time. Protection is also needed for the young lambs, which in southern Nevada may be born as early as mid-January.

When natural protection, such as steep draws, caves, or overhanging ledges, is not present in a bighorn enclosure, an artificial windbreak can

FIGURE 3. Windbreak constructed of four sheets of plywood radiating at right angles to each other.

be made from four sheets of plywood or other material radiating from a common center at 90 degrees to each other, much like the spokes of a wheel. Roofing this windbreak provides protection from storms or the sun, as well as protection from wind from any direction of the compass. A sufficient number of windbreaks or shelters should be provided, so that each animal can get adequate protection. This type of shelter has been used with success at the Corn Creek Headquarters.

Bighorn sheep appear to water more frequently in captivity than in the wild, so a cool, clear, and pure supply of water should be available to them at all times. If a container or tank is used, it should be cleaned frequently. Ditch water can be used if care is taken that it is flowing constantly and does not become stale, warm, and contaminated.

Pre-lambing Care of the Ewe

At the Corn Creek Headquarters bighorn sheep have been reared from lambs caught in the wild and kept for eight years on a diet of bright alfalfa hay and a daily ration of oats or rolled barley. The hay is fed morning and evening and the grain is given once a day. This feed is supplemented by weeds, four-winged saltbush, and bermuda grass that grow in portions of the pasture.

One ewe dropped weak lambs two years in succession; this condition was corrected by isolating her from the ram three months before parturition and giving her a daily supplemental feeding of one teaspoon of *Vitamycin*, a commercial vitamin-mineral powder, which was placed in her grain. When it is possible to mix feed for the animals, the balanced diet prescribed by Dr. Crosbie (Table 1) may be added to a hay or browse feed and should result in healthier animals the year-round. The hay or browse is needed with the diet for roughage.

TABLE 1

Balanced Supplemental Ration for Fenced Bighorn Sheep

Item	*Parts*	*Item*	*Parts*
Rolled oats	100	Iodized salt	1
Oil meal	10	Bone meal	1
Hominy	20	Calcium	0.25
Ground oats	20	Stock mineral feed	1.25
Beet pulp	10	Molasses	15
Wheat germ meal	3	Bran	10
Brewer's yeast	2		

The above ration is to be given with roughage such as hay or browse.

Overfeeding is one of the ewe's major causes of trouble at lambing time. For domestic sheep it has been found that heavy grain feedings just before lambing are likely to cause udder trouble, and the overfeeding of rich concentrates may cause abortion or preparturient paralysis (Miller, 1930). Overfeeding of a young ewe that is having her first lamb may result in a lamb too large for her to pass. This occurred in the case of a ewe at the Corn Creek Headquraters that was bred in her yearling year.

Three weeks or a month before the estimated lambing date the grain ration should be cut to one pint or less a day. This will have no effect on the lamb, since it is fully formed, and may prepare the ewe for normal delivery. So that each ewe will obtain her grain ration, as many grain boxes as there are animals should be provided and the boxes should be kept scattered. After the lamb is born, the grain feeding should be omitted entirely for five or six days. If a ewe is to be dried up, grain should not be fed for two or three weeks.

When a balanced, prepared diet is not available, alfalfa hay alone is a very good feed for pregnant ewes. Since bighorn ewes eat but the finer portions of the hay, the danger of overfeeding is not pronounced. The animals should be fed only what they will clean up at one feeding, and the uneaten portions should be removed daily. In the wild bighorn sheep eat several times daily, but two feedings a day are ample for captive bighorn provided with sufficient food for their daily requirements.

Indications of Lambing

Several days before her time to lamb, the ewe will begin to develop an udder. In addition, the genitals will appear swollen. This is the time to make last-minute preparations before the lamb is born. Just before lambing, the ewe becomes restless and appears sunken in front of the hips. There is a noticeable increase in her rate of respiration. At this time it is advisable to isolate the ewe in a smaller pen or in one of the units of the bighorn pasture.

Parturition

The act of giving birth begins with the rupture of the amnion, which releases considerable fluid through the vulva. Several hours may elapse after this initial flow has begun before the lamb is born, but if birth does not occur by then the services of a veterinarian to assist with the birth should be obtained. If a veterinarian cannot be obtained, it may be prudent to attempt to assist the ewe without his services.

The normal anterior position of the lamb at birth is with the forelegs extended and the head resting between them. The lamb is facing outward. The birth of the lamb in this position usually takes place without assistance, but difficulty may occur if the lamb is not in the correct position or if it is too large for the pelvic girdle opening. If the lamb is not in the proper position it can be assisted by inserting the hand into the vulva and gently turning the fetus into the proper position. When the position of the lamb has been corrected, further assistance can be given by looping a heavy string or cord around the front legs and gently pulling outward and downward as the ewe strains. Before the ewe is entered, the fingernails should be trimmed, the hands and arms thoroughly cleansed with soap and water, and then vaseline or olive oil rubbed on the hands. If the womb and vagina of the ewe have been lacerated by the operation, use of uterine capsules made from a mild antiseptic or sulfa powder or a douche of one pint of 1 percent Lugol's solution, repeated in two or three days if excessive discharge remains, is recommended.

It may be several hours after the birth of the lamb before the afterbirth is passed by the ewe. As eating a portion of this tissue appears to be a normal act of parturition, it should be left with the ewe. The ewe may experience a slight secretion from the vulva for two or three weeks after parturition. This condition usually is not serious and eeases in due time, but should be eheeked by a veterinarian to assure that complications have not followed the birth of the lamb.

Postnatal Care of the Ewe

The ewe, after the birth of the lamb, should be given every opportunity to develop an interest in her offspring and to claim it as her own. Observations on the newborn lamb can be made from a distance with binoculars, and if the ewe is seen to cleanse the lamb of mucus the battle is half won, and if the lamb is seen to nurse, the claiming is completed.

At the Corn Creek Headquarters a ewe refused to claim her first three lambs. It was thought that this was due to harassment from the one ram in the small herd and the interest displayed in the lamb by another ewe. Three months before the fourth lamb was born the ewe was isolated in a portion of the bighorn pasture and allowed to enjoy the peace and rest sought by ewes in the wild at this time of the year. When this lamb was born the ewe displayed every indication of maternal pride and ownership, but as the hours passed she continued to resist the lamb's efforts to nurse. After several hours it was feared that the health of the lamb might be in jeopardy unless it obtained some of the colostrum to clear the bowels, and since the ewe was tame enough to permit handling, she was milked out and the lamb was fed by bottle. This feeding increased its strength and the lamb continued its efforts to nurse the ewe and was finally successful. Relief of some of the pressure on the udder of the ewe by milking her out may have played a part in her acceptance of the lamb to nurse.

A ewe, when she claims her lamb, will clean it of all external mucus and other matter that accompanies parturition. The umbilical cord is severed, and it is thought that this is also done by the ewe, although the act has not been witnessed on the Desert Game Range. If the ewe will not claim the lamb, the lamb's nostrils should be carefully cleaned of phlegm or other obstructions and wiped dry with a soft cloth. The umbilical cord should be cut off about six inches from the stomach of the lamb and the stump sterilized. Care should be taken to see that the lamb does not become chilled.

Feeding the Lamb

The colostrum, or first milk, when given to the lamb by the ewe or by bottle, acts as a laxative and clears the bowels. If a ewe refuses to allow a lamb to suckle she can be held and milked out by hand and enough milk obtained for several feedings. The colostrum will keep under refrigeration. If the first milk cannot be obtained a teaspoon of milk of magnesia should be added to the substitute milk during the first day or two.

TABLE 2

Feeding Schedule for Bighorn Lambs

Age	Schedule
1st and 2d day	Two and one-half tablespoons every two hours. Feed the colostrum the first two days, if possible, and omit night feedings.
3d and 4th day	Three and one-half tablespoons five times a day.
5th to 12th day	Gradually increase to one-half cup (4 ounces) four times a day. Feed morning, noon, evening, and late at night.
13th to 20th day	Gradually increase to three-fourths cup (6 ounces) four times a day.
21st to 28th day	Gradually increase to one pint three times a day.
29th day to 2 months	One pint three times a day.
2 months to 3 months	One pint twice a day.

After one month of age the lambs will require supplements and solids in addition to the above diet of milk or prepared formula.

When a lamb must be reared without its mother, goat milk may be used as an acceptable substitute food. It more closely resembles domestic sheep milk than does cow milk, and cow milk will often cause scours unless white Karo syrup is added. The reason for this is not fully known, since cow milk supposedly has a higher sugar content than goat or domestic sheep milk. "Bummer" lambs from domestic herds tested by the author showed far more gain in size and weight on goat milk than on fresh, unpasteurized cow milk during the first two months.

FIGURE 4. Young bighorn lamb, recently subject to scours, being bottle fed at the Corn Creek Headquarters of the Desert Game Range.

The following formula for raising lambs on a bottle was developed by Dr. Crosbie and has been successfully used at the San Diego Zoo.

> Take two tablespoons of pearl barley and add one pint of water. Boil in double boiler one hour. Strain and add boiling water to make one pint of liquid. Add one pint of condensed cow milk. Start out with one ounce feedings every four hours. Add one drop of concentrated Vitamin A and D oil to each feeding.

Additional feeding schedules and amounts per feeding have been worked out on the basis of experience with bighorn lambs at the Corn Creek Headquarters, experiments on domestic lambs by the author, and the work of others with domestic sheep. If the lamb is bottle-fed, the food can be measured out, and if the lamb is nursed by a goat the feeding period should be kept short, since it is better to keep the lamb a little underfed than overfed during the first few days. Ewes in the wild have been observed to let the small lambs nurse about one minute. On bottle feedings, the milk should be warmed to about 100 degrees F.

All lambs will not react in the same way to the feeding schedule or formula. If at any time a lamb appears to be in distress shortly after feeding, a veterinarian should be called, and if none is available, checks should be made for constipation, indigestion, or scours, and treatment applied in accordance with instructions. At three months of age the lamb may be weaned gradually, but if milk or a prepared formula are available, they may be given for another month.

TABLE 3

Composition of Milk of the Cow, Goat, and Domestic Sheep

Compiled by Leonard J. Goss

Species		*Water*	*Fat*	*Sugar*	*Percentages* *Protein*	*Casein*	*Albumin*	*Ash*
Cow	(1)	87.2	3.8	4.95	3.35	2.75	.06	.07
	(2)	--	3.7	4.9	--	--	3.5	.70
	(3)	86.21	4.45	4.86	3.77	--	--	.72
	(4)	88.0	3.4	4.4	3.3	--	--	.70
Goat	(1)	85.71	4.78	4.46	4.29	3.2	1.09	.76
	(2)	--	4.3	3.6	--	--	3.7	.80
Sheep	(1)	83.0	5.3	4.6	6.3	4.6	1.7	.80
	(2)	--	9.3	5.0	--	--	4.9	.80
	(3)	82.9	6.24	4.29	5.44	--	--	.85

(1) Von Bunge Analysis.
(2) U. S. Dept. of Agriculture Yearbook, 1939.
(3) Handwörterbuch d. Naturwissenchaften, 1932, p. 987-988.
(4) Fleischmann, W., 1951, p. 145-146.

Supplemental and Solid Foods

When the lamb is three weeks to one month of age, it will begin to take grain, hay, prepared foods, and green vegetation in considerable amounts. It will nibble at hay and grass at an earlier age, but does not have sufficient teeth to chew properly. If the ewe and lamb are not on green pasture, it may be advisable to keep a small amount of bright alfalfa hay in their presence at all times, since the curious lamb will nibble at anything, and at Corn Creek has even been observed to eat portions of the droppings of the ewe. After the lamb is a month old, it may be fed a small portion of equal parts of whole oats, rolled barley, and wheat bran once a day. Grain will also act to check the lamb in eating indigestible or undesirable material. The lamb should be put on

pasture as soon as possible, since there is nothing better for it than green grass, weeds, sunshine, and exercise.

If it is not practical to feed fenced bighorn a balanced, prepared diet, it is generally wise to give some supplemental food as an additional source of nourishment. Several prepared products composed primarily of vitamins and minerals in concentrated form are available on the market. Some of these are to be used only under the directions of a competent veterinarian. Since most of these preparations are expensive if given regularly, they should be resorted to when animals are in advanced stages of malnutrition and require immediate, effective treatment. Mineral blocks and prepared stock feeds that contain ingredients such as bone meal, potassium, iodine, limestone, salt, molasses, anise, iron oxide, copper sulphate, manganese sulphate, cobalt carbonate, and other minerals may be utilized as supplemental food. At Corn Creek bighorn sheep ignored the prepared mineral block, although they were licking common rock salt, so the block was powdered and a small portion mixed with the daily grain ration. A bighorn ewe was observed to lick rock salt for several minutes a few hours after her lamb was born.

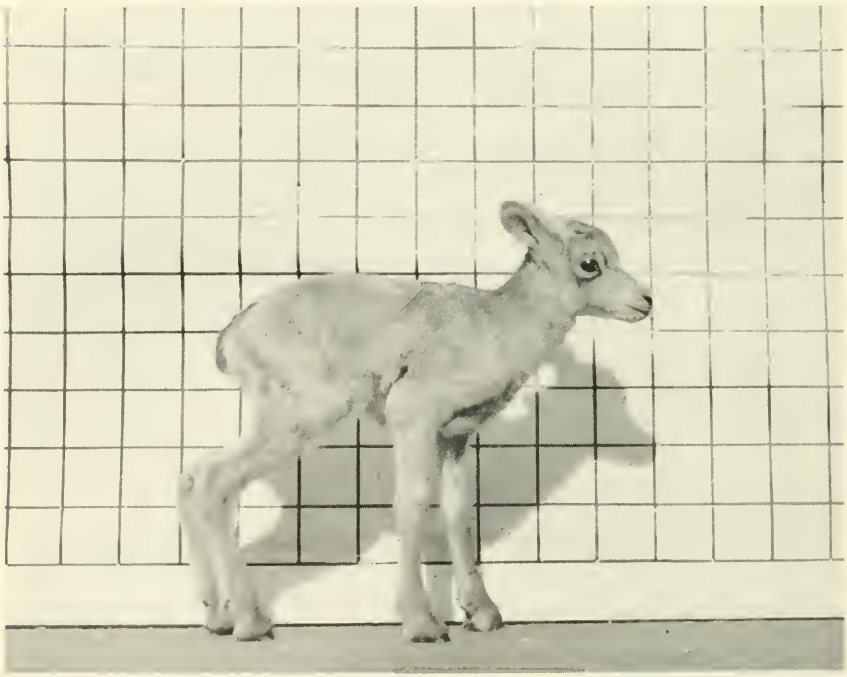

FIGURE 5. Visual records of lamb growth are made with three-inch grids. This lamb is 32 hours old.

DISEASES OF BIGHORN LAMBS

Bighorn lambs reared in captivity appear to be more susceptible to various ailments than domestic lambs raised under similar conditions. Many of these ailments originate in the digestive system from various

causes, but most of them can be effectively controlled through sanitation and proper diet. It is highly important that at the first sign of lamb trouble a veterinarian be consulted, but the ability to diagnose and give temporary emergency treatment for the more common ailments is useful if the services of a veterinarian cannot be obtained. The ability to describe external symptoms of illness is also an asset if it is necessary for a veterinarian to prescribe treatment by telephone or mail.

Constipation

Constipation is one of the most common troubles of young lambs and is indicated by straining, distress, and sickly appearance. One or two teaspoons of warm castor oil, depending upon the size of the lamb, are recommended for treatment.

Diarrhea or Scours

Diarrhea can be caused by overfeeding or too close confinement of the lamb. Cold, damp, soiled quarters can also contribute to the outbreak of this disease, which strikes many young animals. Diarrhea is indicated by soiled buttocks and watery, fetid excrement. For emergency treatment one tablespoon of cooking soda in a small amount of warm milk, followed in about four hours with one ounce of white mineral oil, should be given. Exercise and sunshine will assist the cure.

Indigestion

Indigestion is characterized by distress and frothing at the mouth. It is usually caused by overfeeding or eating of indigestible substances. Emergency treatment for larger lambs consists of a liberal dose of castor oil. A few drops of Castoria in warm water have been effective at Corn Creek for lambs a day or two old.

Chilliness

Sometimes a lamb becomes chilled and must be warmed by artificial means. A chilled lamb may be placed on an old blanket or sheep pelt beside a stove or heater and rubbed vigorously to increase circulation. A very handy and effective method is to place the lamb on an ordinary hot water bottle or heating pad, being careful not to burn the animal. If the lamb has been exposed to cold or wetness for a considerable period of time and is severely chilled, it may be bathed for 10 minutes in water as hot as the hand can bear, then rubbed thoroughly dry and wrapped in a hot flannel cloth or on a blanket beside a warm stove. Unless checked immediately, chilling is often followed by lung congestion and pneumonia.

Sore Eyes

Sore eyes are encountered at times among domestic lambs but have not been observed to date among the Corn Creek bighorn. Treatment for domestic lambs varies but consists primarily of disinfecting and cleansing the eye with an eye wash. For emergency treatment, an eye wash consisting of a strong saltwater solution or a saturated solution of boric acid applied twice a day with an eye dropper may be used.

Arthritis

Arthritis is also known as inflammation of the joints and in young lambs is caused primarily by the infection of the navel stump at birth. External symptoms are swelling of the joints, lameness, loss of appetite, diarrhea, and progressive weakness. Lambing under sanitary conditions and sterilization of the navel stump as soon as possible after birth are the best preventatives. The navel stump can be sterilized by placing it for a minute or two in a wide-mouth bottle containing tincture of iodine. No particular emergency treatment is recommended. Recovery is common, but the lamb may suffer damage to the joints and display a general debility. Other serious lamb diseases have also been traced to an infected navel.

Dysentery

Dysentery is sometimes called white scours and is a disease that is usually filth-born. It can be prevented by proper sanitation in the sheep quarters. Lamb dysentery may occur within 48 hours or a week after the birth of the lamb and is characterized by a watery, gray diarrhea with an offensive odor. The lamb becomes depressed and ceases nursing. Lambs surviving the first 48 hours of illness may slowly recover. This is a disease which should be treated by a veterinarian.

White Muscle Disease

The cause of white muscle disease apparently is not known. It is characterized by muscular degeneration, usually in lambs between three and ten weeks of age. Autopsies on domestic lambs that have died of the disease have shown whitish or grayish streaks in the leg muscles. Nutritional deficiencies and autointoxication are suspected as being the causes of the disease. There is no known successful treatment, but proper feeding and exercise of the lambs, with sufficient vitamins and minerals in the diet of the pregnant ewes, should prevent its occurrence.

Eating Indigestible Substances

Lambs often nibble at anything around them, but among domestic lambs this trait has been found to be stimulated beyond normal by a depraved appetite caused by a mineral deficiency in the diet. Foreign substances often cause indigestion and sometimes death from stoppage of the intestines. Toxins are then absorbed from the digestive tract and the lamb ceases eating, acts stupefied, and usually dies. This tendency to nibble can be directed into nonharmful channels to some extent by providing green pasture or putting small quantities of ground grain or bran before the lambs.

Neglected Feet

Lambs that are on pasture or in enclosures that have soft, smooth underfooting require periodic trimming of the hoofs. If this task is neglected the toes grow out long and the wall of the foot turns in, causing a deformed hoof. Hoofs in this condition are more susceptible to foot rot than are normal ones. If the hoof is soft, it can easily be trimmed with a pocket knife or a pair of pruning shears. If at least a portion of the bighorn pasture includes rough, rocky terrain, trimming seldom, if ever, need be resorted to. In small enclosures, quite rough-surfaced concrete will also help materially.

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THE CRUDE PROTEIN VARIATIONS IN THE BROWSE DIET OF CALIFORNIA DEER[1]

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INTRODUCTION

Deer in California *(Odocoileus hemionus)* are subject to considerable natural losses resulting from nutritional deficiencies during certain seasons and on different ranges. This paper will show the potential protein content of the diet throughout the year, which bears a relationship to this problem.

Many other workers throughout the United States have reported chemical analyses of deer foods, among them Aldous (1945), Einarsen (1946), Gordon and Sampson (1939), Hagen (1953), Hellmers (1940), Reynolds and Sampson (1943), and Swift (1948). Many of these, however, are reports on eastern white-tailed deer *(Odocoileus virginianus)* or on vegetation which is of little importance in the diet of California deer. Few investigators, with the exception of livestock workers, have reported year-round figures on plant composition. However, the latter have emphasized grass and forb analyses to the exclusion of browse. There is a need for browse analyses to complete the picture for the deer nutrition worker.

Crude protein was chosen as the major item to be determined for each plant sample. This was considered best for several reasons. (1) Most American feeding standards for domestic ruminants are based upon the crude protein content of the feed, and thus, the benefits of the vast literature on livestock feeding may be utilized. (2) Protein is the foodstuff most important for maintenance and for growth. (3) The crude fiber content of plants is extremely important in influencing the digestibility of crude protein and in supplying energy through its own breakdown into soluble carbohydrates. However, the crude fiber determination was considered too lengthy to be applied to the large number of plant samples being evaluated. (4) Total ash is a meaningless figure in deer nutrition, although useful in the economics of commercial feed production. (5) Fat content of plants as a rule is very low in the plant structures which deer commonly eat, and the importance of fat in ruminant nutrition appears to be of little significance in their case.

[1] Submitted for publication December, 1954. Federal Aid in Wildlife Restoration Project California W-25-R, "Food Habits Investigations." The authors wish to express their appreciation to the many field personnel of the California Department of Fish and Game who cooperated in collecting samples for analysis and in determining collection sites. Special mention should be made of the excellent collection of Lake County chaparral plants obtained through the assistance of Dr. R. D. Taber, and of the initial direction of the study by Dr. A. Starker Leopold.

It certainly is true that the approach may be oversimplified, since the calcium/phosphorus ratio, vitamin content, obscure growth factors, and specific amino acids or fatty acids in various plants actually may be limiting factors in deer nutrition.

The basis for the individual's good health lies in proper nutrition. Successful breeding, low rates of abortion or still births, high fawn survival, and general well being, including high resistance to parasitism or infectious disease, are mandatory for a herd to remain in good condition.

METHODS

Methods of the Association of Official Agricultural Chemists (1950) were used to determine crude protein. The modification of Scales and Harrison (1920) using boric acid to collect ammonia was employed. In all cases only those portions of the plant considered to be equivalent to those consumed by deer were analyzed. In the majority of instances, such portions consisted of the leaves and stems of the two to six inches of the current year's growth. A constant check was made on the accuracy of the determinations through the use of duplicate samples and periodic analyses of standard nitrogen solutions.

The variability of the protein content of plants of the same species is to be emphasized. Even adjacent plants may vary in protein values as much as 20 percent. For this reason it is desirable to analyze several plants and combine the results to get an average value for each species. These combined samples represent all samples taken from all areas in the State collected in the same month. Factors such as differences in growing seasons, age of above-ground structures, and soil types obviously were not considered.

The total number of analyses combined to give each result is placed within parentheses under each month's heading in Table 1. These analyses range in number from 1 to 22. The confidence in each result is in proportion to the number of samples combined.

Most plant samples were collected by the senior author or by Department personnel. The samples were either weighed immediately or placed in sealed glass jars or moisture-proof plastic bags, so that the water content of the plants could be determined. The labeled plant parts were taken to the Food Habits Laboratory, where the samples were oven-dried and finely ground preparatory to analysis.

DISCUSSION

The general impressions from these analyses are that big sagebrush, buck brush, wavyleaf ceanothus, western mountain mahogany, and coffeeberry are outstanding year-long browse plants in terms of crude protein content.

Scrub oak, interior live oak, bitterbrush, desert mountain mahogany, toyon, and wild plum appear to be plants of steady, although somewhat lower, protein content. Most of the other plants listed in Table 1 are good to excellent during at least one season of the year, and some are good during the time they hold their leaves.

TABLE 1

Monthly Crude Protein Content of Deer Browse Species Expressed in Percentages (Oven-dry Basis)
(Numbers in parentheses represent the number of samples used to derive the protein values)

Browse species	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Pinon Pine	5.7	6.5	6.5	7.5	—	—	—	—	—	—	—	6.9
Pinus cembroides	(1)	(1)	(1)	(1)								(1)
Sierra Juniper	6.9	5.6	7.2	7.0	8.3	—	—	7.5	—	7.8	8.5	7.0
Juniperus occidentalis	(3)	(3)	(3)	(3)	(2)			(1)		(1)	(2)	(3)
Willow	7.3	7.3	12.1	18.6	—	—	—	—	—	—	—	4.6
Salix spp.	(1)	(1)	(1)	(1)								(1)
Coast Live Oak	—	—	—	—	—	—	—	—	—	—	—	4.6
Quercus agrifolia												(1)
Blue Oak	5.2	—	—	—	—	—	—	—	—	—	—	—
Quercus douglasii	(1)											
Scrub Oak	8.0	8.9	9.9	13.7	14.6	12.4	11.1	7.2	7.0	6.1	9.3	7.4
Quercus dumosa	(7)	(6)	(8)	(9)	(10)	(11)	(8)	(6)	(16)	(11)	(6)	(9)
Leather Oak	—	—	—	—	—	—	—	—	—	—	—	8.3
Quercus durata												(1)
Canyon Oak	—	—	—	—	—	—	7.9	5.1	—	6.8	—	—
Quercus chrysolepis							(1)	(1)		(1)		
Oregon Oak	—	—	—	—	—	—	—	—	—	11.6	5.2	—
Quercus garryana										(2)	(2)	
Grey Oak	7.7	7.3	7.5	6.9	—	—	—	—	—	—	—	—
Quercus turbinella	(1)	(1)	(1)	(1)								
Interior Live Oak	8.9	8.7	8.3	17.5	17.6	11.1	9.7	10.0	6.7	6.8	8.2	7.5
Quercus wislizenii	(2)	(1)	(6)	(3)	(4)	(8)	(6)	(7)	(6)	(5)	(2)	(1)
California-buckwheat	6.1	6.1	7.2	17.8	—	—	—	—	—	—	—	6.7
Eriogonum fasciculatum	(1)	(1)	(1)	(1)								(1)
California Laurel	11.4	—	—	—	28.3	21.1	25.0	15.2	15.4	15.2	—	—
Umbellularia californica	(3)				(3)	(4)	(1)	(2)	(5)	(2)		
Black Bush	6.5	5.6	5.6	8.7	—	—	—	—	—	—	—	6.1
Coleogyne ramosissima	(1)	(1)	(1)	(1)								(1)
Chamise	5.9	8.3	11.3	14.3	14.4	10.0	9.1	5.9	6.1	4.4	6.9	6.9
Adenostema fasciculatum	(12)	(11)	(13)	(12)	(19)	(22)	(13)	(13)	(22)	(10)	(8)	(8)
Desert Peach	—	—	—	16.2	—	—	—	—	—	—	—	—
Prunus Andersonii				(1)								

TABLE 1—Continued

Monthly Crude Protein Content of Deer Browse Species Expressed in Percentages (Oven-dry Basis)
(Numbers in parentheses represent the number of samples used to derive the protein values)

Browse species	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Bitter Cherry	—	—	—	—	—	—	13.3	—	9.7	—	—	—
Prunus emarginata							(1)		(1)			
Hollyleaf Cherry	—	—	—	—	23.4	17.0	20.0	16.2	12.3	—	—	—
Prunus ilicifolia					(2)	(2)	(1)	(2)	(3)			
Sierra Plum	—	—	—	26.0	14.3	10.4	—	—	—	10.5	—	—
Prunus subcordata				(1)	(1)	(1)				(1)		
Western Choke-cherry	—	—	—	21.4	—	—	7.5	—	13.2	9.7	—	—
Prunus virginiana				(1)			(1)		(1)	(1)		
Bitterbrush	7.4	6.9	6.9	9.9	10.8	—	—	11.4	—	9.0	9.7	8.0
Purshia tridentata	(11)	(10)	(5)	(11)	(3)			(3)		(5)	(9)	(9)
Western Mountain-Mahogany	7.3	6.5	14.1	16.8	15.0	12.2	11.7	9.0	8.3	7.6	9.7	9.3
Cercocarpus betuloides	(5)	(3)	(6)	(7)	(2)	(5)	(4)	(7)	(6)	(9)	(6)	(4)
Desert Mountain-Mahogany	7.4	6.2	6.3	7.3	9.4	—	8.3	12.3	—	—	7.9	8.8
Cercocarpus ledifolius	(3)	(2)	(1)	(2)	(1)		(1)	(1)			(1)	(1)
Toyon	9.0	—	8.9	15.3	16.4	13.9	11.4	8.5	8.0	7.0	8.3	6.7
Photinia arbutifolia	(1)		(1)	(1)	(3)	(3)	(5)	(2)	(7)	(6)	(1)	(1)
Western Service Berry	—	—	—	—	—	13.3	—	11.3	—	6.8	4.3	—
Amelanchier alnifolia						(1)		(2)		(2)	(1)	
Chaparral-pea	—	8.1	—	19.2	18.1	14.3	11.5	11.4	6.1	7.5	—	—
Pickeringia montana		(1)		(1)	(1)	(2)	(1)	(4)	(1)	(3)		
Poison-oak	—	—	24.2	22.6	20.6	15.7	10.1	9.9	6.5	4.2	—	—
Rhus diversiloba			(1)	(2)	(3)	(4)	(1)	(3)	(4)	(3)		
Squaw Bush	—	—	—	19.4	—	14.9	10.7	10.5	11.1	6.1	8.5	—
Rhus trilobata				(2)		(3)	(2)	(3)	(4)	(3)	(1)	
Buckeye	—	—	26.4	31.2	—	20.8	20.3	11.2	11.4	4.8	—	—
Aesculus californica			(1)	(1)		(1)	(3)	(1)	(2)	(1)		
Mountain Whitethorn	—	—	—	—	—	6.3	15.2	10.8	—	10.0	—	—
Ceanothus cordulatus						(1)	(1)	(2)		(2)		
Buck brush	8.0	7.8	9.2	15.6	12.4	9.5	7.9	10.4	7.5	6.5	7.0	8.1
Ceanothus cuneatus	(6)	(4)	(5)	(5)	(5)	(2)	(5)	(5)	(4)	(12)	(4)	(4)
Wavyleaf Ceanothus	7.5	9.8	13.3	17.0	25.0	10.8	9.0	7.1	8.1	7.2	7.5	7.9
Ceanothus foliosus	(2)	(1)	(2)	(2)	(1)	(1)	(1)	(3)	(3)	(3)	(1)	(1)
Deer Brush	—		—	25.2	—	—	—	13.7	—	8.9	—	—
Ceanothus integerrimus				(7)				(4)		(3)		

Chaparral Whitethorn	—	—	—	21.2	—	—	—	13.2	—	—	—	—
Ceanothus leucodermis				(1)				(3)				
Squaw Carpet	5.4	—	—	6.5	—	9.2	8.0	9.8	7.5	8.0	—	—
Ceanothus prostratus	(1)			(1)		(1)	(2)	(3)	(1)	(2)		
Snowbrush	7.1	—	—	8.4	—	18.3	11.3	12.9	9.7	11.1	—	—
Ceanothus velutinus	(1)			(1)		(1)	(3)	(3)	(3)	(1)		
Coffeeberry	14.9	7.9	11.5	9.5	22.1	21.2	16.9	18.2	—	11.6	—	11.6
Rhamnus californica	(2)	(1)	(2)	(1)	(2)	(2)	(2)	(3)		(4)		(1)
Redberry	7.6	—	—	—	16.3	10.0	—	10.8	7.4	7.9	—	—
Rhamnus crocea	(2)				(2)	(1)		(1)	(1)	(1)		
Fremont Silktassel	7.9	8.4	9.3	12.0	10.2	10.4	6.9	5.1	5.9	6.4	6.0	6.0
Garrya Fremontii	(4)	(3)	(5)	(4)	(1)	(2)	(3)	(1)	(1)	(6)	(4)	(3)
Eastwood Manzanita	—	5.2	6.3	11.4	12.5	10.7	6.7	6.0	6.4	4.7	—	—
Arctostaphylos glandulosa		(1)	(2)	(1)	(4)	(4)	(4)	(3)	(4)	(4)		
Green Manzanita	5.6	5.2	5.8	6.7	5.8	6.6	6.8	7.8	7.8	6.8	—	6.3
Arctostaphylos patula	(1)	(1)	(1)	(1)	(1)	(1)	(2)	(3)	(2)	(1)		(1)
Stanford Manzanita	—	5.5	6.4	5.3	9.9	7.1	5.8	—	5.6	6.2	—	—
Arctostaphylos Stanfordiana		(1)	(1)	(1)	(1)	(1)	(1)		(2)	(1)		
Whiteleaf Manzanita	—	—	—	—	—	5.2	2.0	5.8	4.5	—	—	—
Arctostaphylos viscida						(1)	(1)	(1)	(1)			
Manzanita	4.2	5.8	6.2	6.2	—	—	—	—	—	6.7	5.8	5.8
Arctostaphylos spp.	(1)	(1)	(1)	(1)						(1)	(1)	(1)
Yerba Santa	7.5	9.6	9.7	17.0	12.3	9.3	5.4	6.5	6.0	7.3	7.0	7.2
Eriodictyon californicum	(9)	(12)	(12)	(15)	(5)	(7)	(7)	(6)	(10)	(8)	(7)	(5)
Rabbitbrush	5.1	5.9	5.3	8.9	—	—	—	—	—	—	—	5.4
Chrysothamnus teretifolius	(2)	(1)	(1)	(1)								(1)
California Sagebrush	—	—	13.1	—	12.6	—	10.4	—	8.8	10.7	—	—
Artemisia californica			(1)		(2)		(1)		(1)	(1)		
Big Sagebrush	9.9	9.8	9.2	11.8	9.2	—	10.8	9.6	—	10.7	9.8	9.8
Artemisia tridentata	(8)	(8)	(6)	(12)	(1)		(1)	(3)		(7)	(6)	(7)

TABLE 2

Percentages of Moisture on Oven-dry Basis

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Interior Live Oak *Quercus wislizenii*	—	—	85	258	233	175	159	127	108	97	117	43
Chamise *Adenostoma fasciculatum*	51	18	140	221	178	145	145	77	96	77	98	89
Western Mountain Mahogany *Cercocarous betuloides*	—	—	257	169	195	119	126	67	79	84	168	—
Toyon *Photinia arbutifolia*	—	—	247	257	261	249	239	210	146	123	198	104
California Buckeye *Aesculus californica*	—	—	529	536	—	415	262	220	281	191	—	—
Buck Brush *Ceanothus cuneatus*	—	—	—	135	154	—	117	100	76	77	—	—
Wavyleaf Ceanothus *Ceanothus foliosus*	57	20	133	212	129	94	40	60	31	81	25	47
Eastwood Manzanita *Arctostaphylos glandulosa*	—	62	107	155	213	194	108	153	115	116	—	—
Yerba Santa *Eriodictyon californicum*	78	55	135	252	155	144	63	—	—	—	—	—
California Sage *Artemisia californica*	—	—	229	—	151	—	95	—	89	100	—	—

As a rule the protein content of any plant is highest during the growth period (succulent stage; spring and summer) and lowest during the dormant period (fall and winter).

It appears, regarding the picture strictly from the viewpoint of crude protein content (dry weight basis), that deer in chaparral ranges would be in poorest condition during the late summer and fall seasons.

Data on the diet of a typical chaparral deer herd are given in Table 3.

Longhurst et al. (1952) and Taber (1954) report that deer die-offs in coastal chaparral ranges occur in the fall and early spring seasons. Early spring die-offs, when protein values are at a high level on a dry weight basis, are difficult to explain unless the factor of water content of the succulent spring growth is considered.

Actually, even though analyzing well for protein on a dry weight basis, succulent new plant growth will supply only one-third to one-tenth of the protein per paunchful that plants may supply later in their growth stage. It is to be noted that protein contents are given on a dry weight basis (Table 1), e.g., 7 percent protein means that of each 100 pounds of dry matter seven pounds are protein. However, the situation per pound (or paunchful) of actual forage consumed is quite different.

Moisture content of typical browse plants is presented in Table 2. It will be seen that in a plant analyzing 200 percent moisture (on a dry weight basis), for every 100 pounds of plant eaten, 66.7 pounds is water and 33.3 pounds dry matter. To carry it a step further, a plant analyzing 15 percent protein in the spring may contain only 5 percent protein on a wet basis.

A plant in the fall analyzing 50 percent water and 15 percent protein on a dry weight basis would, therefore, contain 10 percent protein on a wet basis (as collected) or 100 pounds of original plant material would contain 66.7 pounds of dry matter and 33.3 pounds of water.

Thus, it is possible for a deer feeding on young succulent forage in the spring to have actually less protein per unit of food consumed than a deer eating dormant drier vegetation in the fall (DeNio, 1938). It would take a considerable difference in digestibility to compensate for this difference.

Deer on the Great Basin winter ranges eat a relatively simple diet, whose basic protein level appears to be consistent and good (an example is shown in Table 4). The digestibility of bitterbush is only slightly less than that of alfalfa hay and that of sagebrush is extremely variable, but of high potential value (Bissell et al., 1955; Smith, 1950). It appears that deer have available adequate sources of digestible energy and protein, providing that bitterbrush and sagebrush are available in sufficient quantities. Sagebrush was found to contain never less than 9 percent protein. However, deer normally lose weight on winter ranges, as has been reported by Bischoff (1954), Doman and Rasmussen (1944), and Gerstell (1937), but in ordinary circumstances such weight loss is not serious. Problems of die-offs on these winter ranges apparently center about shortages of palatable forages. Further, deep snows and excessive cold may adversely affect deer conditions by restricting movements and increasing energy requirements.

TABLE 3

Deer Stomach Analyses—Lake County
(Volume Percentages)

(After Leach—Unpublished Data)

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Oak species	trace	13.5	trace	trace	—	—	—	0.9	3.3	trace	0.7	trace
Interior Live Oak	11.4	—	12.9	5.6	41.8	32.7	11.2	0.8	11.5	11.3	0.7	trace
Scrub Oak	1.2	—	—	4.1	21.6	trace	0.6	14.4	50.5	14.8	5.4	0.4
California Laurel	trace	4.4	1.1	trace	trace	0.8	1.5	0.3	0.3	1.8	1.7	17.3
Western Mountain Mahogany	trace	trace	trace	trace	0.2	1.7	0.4	3.6	0.9	0.1	trace	trace
Chamise	68.6	41.7	26.4	60.7	7.0	11.5	24.6	34.5	11.5	9.6	28.9	54.4
Toyon	1.0	trace	trace	trace	0.5	1.5	trace	4.4	6.7	3.6	—	6.1
Chaparral-pea	0.2	trace	trace	—	trace	1.2	trace	0.9	trace	18.2	0.3	9.9
Poison Oak	—	—	—	—	trace	9.6	12.4	12.3	1.3	5.9	—	—
Squaw Bush	—	—	—	—	—	—	0.6	3.3	—	—	—	—
California Buckeye	—	—	0.1	—	0.1	4.0	3.5	0.1	trace	—	4.7	—
California Coffeeberry	3.0	1.2	—	—	—	—	trace	0.3	trace	trace	0.3	—
Wavyleaf Ceanothus	trace	—	2.2	0.1	trace	0.8	—	trace	0.1	trace	5.0	trace
Fremont Silktassel	—	—	—	5.8	3.3	—	—	0.9	3.1	trace	trace	1.1
Manzanita species	2.0	2.5	0.8	trace	trace	—	—	0.4	1.1	1.1	—	trace
Yerba Santa	trace	6.0	0.8	trace	trace	—	—	—	trace	trace	3.2	0.3
Total of above species	87.4	69.3	44.2	76.3	74.5	63.8	54.8	77.1	90.3	66.4	50.9	89.5
Other browse	0.2	0.0	0.7	4.6	0.5	27.9	32.1	16.2	3.3	13.9	2.6	0.0
Total browse	87.6	69.3	45.0	80.9	75.0	91.7	86.9	93.3	93.6	80.3	53.5	89.5
Total forbs	2.4	8.4	25.5	17.2	25.0	8.3	13.1	6.1	6.4	17.7	0.6	0.6
Grasses (green)	10.0	21.1	29.5	1.9	trace	trace	trace	trace	trace	trace	45.9	9.9
Grasses (dry)	trace	1.2	—	—	trace	trace	—	0.6	trace	2.0	trace	trace

TABLE 4

Deer Stomach Analyses: Lassen-Washoe Herd Winter Range
(Volume Percentages)

(After Leach—Unpublished Data)

Browse	September	October	November	December	January	February	March	April	May
Juniper	—	—	trace	1.2	trace	0.8	0.5	0.3	—
Black Oak (*Quercus Kellaggii*)	6.2	8.0	2.6	trace	0.3	0.3	0.3	trace	—
Desert Mahogany	10.5	0.9	0.7	5.0	1.6	0.1	trace	9.2	23.9
Choke Cherry	3.3	2.2	—	—	—	—	2.3	trace	—
Bitterbrush	60.2	62.3	51.6	20.5	10.0	9.9	—	4.8	14.7
Squaw Carpet	5.8	0.2	0.8	3.9	—	1.1	0.6	2.0	0.3
Snowbrush	trace	1.5	3.6	2.6	0.3	0.2	0.2	2.5	—
Sagebrush	—	3.5	11.8	26.9	64.9	53.4	54.5	34.4	44.4
Total of above species	86.0	78.6	71.1	60.1	77.1	65.8	58.4	53.2	83.3
Other browse	6.5	7.8	8.6	3.0	2.1	6.5	2.5	4.4	0.0
Total browse	92.5	86.4	79.7	63.1	79.2	72.3	60.9	57.6	83.3
Forbs	7.5	12.6	5.9	8.7	0.6	6.8	8.8	8.0	7.5
Grasses (dry)	trace	trace	8.1	6.3	16.6	7.7	13.1	7.5	trace
Grasses (green)	trace	1.0	6.3	21.9	3.6	13.2	17.2	26.9	9.2
Total grasses	trace	1.0	14.4	28.2	20.2	20.9	30.3	34.4	9.2

Evidence at hand indicates that a 7 percent crude protein level in adequate amounts of palatable browse should maintain deer in situations other than those subjecting them to prolonged cold or stress. However, until the digestibilities of the various browse species at their various growth stages are determined it is not possible to determine the minimum protein levels necessary to maintain deer under all conditions.

SUMMARY

A. The figures on crude protein levels and their seasonal variations should serve as an index to the forage value of the various browse species utilized by deer (*Odocoileus hemionus*).

B. Crude protein levels on a dry weight basis are highest in spring and summer, when plants are succulent and growing, and lowest in the fall and winter, when plants are dormant.

C. Because of the high moisture content of plants during their growth (succulent) periods, the actual amount of crude protein (and other energy-containing material) per unit of material eaten may be lower than when plants are eaten during their dormant periods.

D. The protein level values obtained in connection with stomach analysis data lead to the conclusion that throughout the year the deer have available on their ranges varying amounts of vegetation analyzing 7 percent or better in crude protein content.

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THE STATUS OF THE PUMPKINSEED, *LEPOMIS GIBBOSUS* (LINNÉ), IN CALIFORNIA[1]

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The presence of this introduced sunfish in California was first recorded by Curtis (1949). This is also the only published record of its distribution in the State. His complete statement concerning the species reads: "* * * the pumpkinseed is so rare [in California] that it can for all practical purposes be disregarded * * *. Of the pumpkinseed there were until 1948 only two authentic records in the State, one from near Mecca, Riverside County, in 1939 and one from Modoc County in 1946. Of how these specimens came to be in such widely separated spots, nothing is known. A further importation occurred in 1948, when a number were furnished by the U. S. Fish and Wildlife Service for planting by the owners in Irvine Lake, Orange County."

The paucity of information given here makes it desirable to fill out the known history of the pumpkinseed by a more extended account of the bases for these statements. (One of these also requires correction.) Furthermore, several other records of its presence are now known. Thanks are extended to Dr. Robert Rush Miller of the University of Michigan, Dr. Carl L. Hubbs of the Scripps Institution of Oceanography, Mr. W. I. Follett of the California Academy of Sciences, and

[1] Submitted for publication January, 1955.

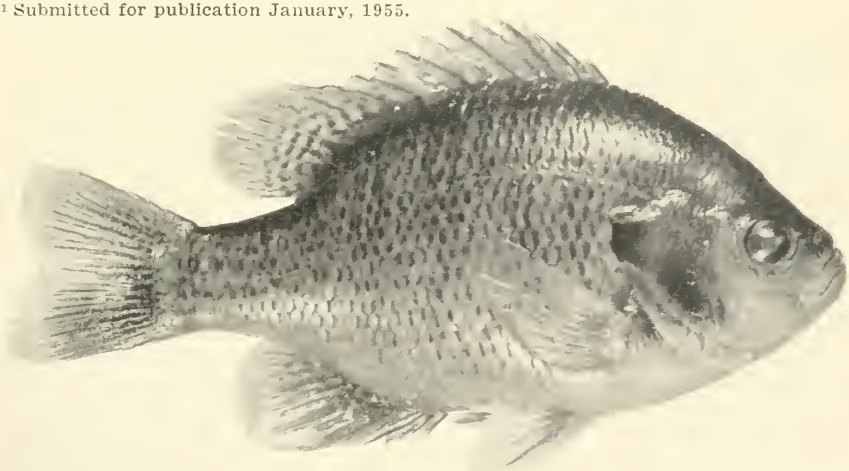

FIGURE 1. A pumpkinseed 5.4 inches long taken from the Susan River, Lassen County, California, on August 16, 1954. *Photograph by J. H. Wales.*

Messrs. N. A. Jorgensen, Jr. and J. B. Kimsey of the Department of Fish and Game, for permission to publish their records (in letter form to the authors). Thanks are also due to Mr. J. H. Wales of the Department of Fish and Game for his photograph, Figure 1.

Our first known record of the pumpkinseed is from an artesian-fed reservoir on the Wise Ranch at the northeast corner of the Salton Sea, south of Mecca, Riverside County. Dr. R. R. Miller and R. G. Miller took three half-grown to adult specimens from here on May 25, 1939 (University of Michigan Museum of Zoology No. 133173). Mr. J. F. Wise (letter of March 7, 1943, to Dill and verbally to Douglas, November 3, 1948) believed that the fish were planted in his pond by a Mr. Sheets about "twenty-five years ago" and came "via train from Washington, D. C." It seems quite probable that these were from a shipment by the old U. S. Bureau of Fisheries in response to a request for stocking from private persons. Mr. Wise believed that the pumpkinseeds had disappeared from his pond by 1943, following an introduction of bullheads (*Ameiurus*) in 1940.

He also recalled that some of these original sunfish were distributed as follows:

Mr. John Hilton of Thermal, Riverside County, received a pair. Douglas checked with him in 1948 and found that these fish had been sent to a friend in San Pedro. He was sure that the fish had died without reproducing.

Mr. C. G. Colly of Mecca had placed several in a fish pond. The present owner of the pond reported that none were present in 1948. "Fig Tree John" at Fish Springs, Imperial County, was also supposed to have received some pumpkinseed from Mr. Colly. No trace of them could be found.

Miss Cecilia Folks of Mecca had several in a pond until about 1941, when a cloudburst washed the fish away.

The Magill Pond, also near Mecca, may have had some of these fish at one time. However, it was pumped dry some years ago and was last known to contain only mosquitofish (*Gambusia*).

The next record of pumpkinseed collection in the State is by Carl L., L. C., and E. L. Hubbs, who took seven half-grown to mature (dwarfed) adults from the Susan River, Lassen County, just below U. S. Highway 395 crossing on July 4, 1942 (UMMZ 141556). Just 11 years later, July 4, 1953, N. A. Jorgensen, Jr. caught another very close to this locality. This was a male, 5.8 inches in fork length.

A survey made one year later, August 16, 1954, by J. B. Kimsey, Robert R. Bell, and W. L. Turner, disclosed a good population in the lower Susan River near Honey Lake. Several hundred individuals ranging from 0.9 to 6.1 inches in fork length were collected.

On September 7, 1942, another collection was made in northeastern California by W. I. Follett, who took three small pumpkinseeds (largest 42 mm. standard length) from Antelope Creek, a tributary of the Lost River, Modoc County, T. 48 N., R. 7 E., sec. 21. The identification was confirmed by Carl L. Hubbs, and the specimens were deposited in the Stanford University Natural History Museum (Cat. No. 40903). This is the Modoc County record referred to by Curtis (*op. cit.*). His "1946" date is a typographical error.

The record by Curtis (*op. cit.*) of pumpkinseed planting in Irvine Lake (Santiago Reservoir), Orange County, was based on field identification alone (by Douglas). On November 15, 1948, a mixed shipment of warmwater fishes from the U. S. Fish and Wildlife Service at Dexter, New Mexico, was placed in this lake under a permit obtained by the Stevenson Lake Corporation. A few of the fish purported to be bluegill (*Lepomis macrochirus*) were identified as pumpkinseed, but specimens were not retained. We have no further knowledge of their presence in this lake or elsewhere in southern California.

The newest locality record for the State was obtained on May 24, 1951, when Coots chemically treated with rotenone a small mining dredge pond along the Klamath River, Siskiyou County, just above the mouth of Horse Creek. This pond had apparently resulted from overflow water from the river. One hundred twenty-two pumpkinseeds ranging from 2.6 to 5.2 inches in fork length were recovered. On May 29, 1951, one was taken in a fyke net from a side channel directly connected with the Klamath opposite Humbug Creek. On June 20, 1951, another dredge pond connected directly with the Klamath River in the same locality was treated and 201 pumpkinseeds were taken. Since that time other specimens have been taken both in the Klamath River and in Copco Lake (formed by the river). Specimens up to about 7 inches long were seen in the lake in 1953.

Both pumpkinseeds and green sunfish (*Lepomis cyanellus*) now appear to be quite common in mining dredge holes and the quieter stretches of the upper Klamath River in California. However, the Klamath is primarily a trout and salmon stream and very little angling is done for the sunfishes.

As with the records for Susan River and the Lost River drainage (Antelope Creek), we have no information as to the origin of the pumpkinseeds in the Klamath. Lost River is connected with the Klamath by a series of canals, but the Susan River has no connection with either stream.

It is obvious that the pumpkinseed occupies but a minor place in California's fishery, but its persistence in varying types of water indicates that a further distribution might enable it to gain a strong foothold throughout the State.

It is, of course, well known as a pan fish in the East. One can distinguish it from the other sunfishes (Centrarchidae) now known from California by the definite scarlet spot on the gill cover, and the prominent blue and orange cheek stripes.

REFERENCE

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FISHES COLLECTED IN THE TROPICAL EASTERN PACIFIC, 1952-53[1]

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INTRODUCTION

An extensive tuna tagging operation from the tuna clipper M. V. INTREPID during the period October 25, 1952, to February 11, 1953, (California Fish and Game Cruise Report C-1-52) offered an excellent opportunity to observe and collect many marine fishes of Central and South America and the Galapagos Islands.

This paper deals with the specimens that were saved frozen or preserved in formaldehyde and brought to the California State Fisheries Laboratory for identification and disposition. Unfortunately, many specimens had to be discarded because of the dearth of preserving facilities and have not been included in this report.

It is hoped that the present collection will aid materially in achieving a better understanding of the habits of these tropical species and of the ranges over which they occur.

METHODS OF CAPTURE

The large number of species represented in this collection is a direct result of the numerous methods of capture employed and the variety of habitats sampled. These methods were:

1. *Hook and Line.*

   Several methods which warrant specific mention under this heading are:

   A. Trolling With Feathered Jigs and Plastic Squids.
   Trolling, while cruising at approximately 10 knots between different fishing areas and bait grounds, resulted in the capture of fast-swimming fish found relatively near the surface of the water.

   B. Bottom Fishing With Handlines.
   Handlines were employed to good advantage when the vessel was anchored or drifting in water less than 400 feet deep. The use of various sizes of hooks baited with live or cut bait resulted in the capture of many of the species dwelling at or near the bottom.

[1] Submitted for publication December, 1954.

C. Rod and Reel.

A good deal of rod and reel fishing was carried out whenever the opportunity arose and several of the more "gamy" species found near the surface were taken.

2. *Bait-net Hauls.*

Tuna clippers use a large quantity of live bait in normal fishing activities. This bait is captured in relatively shallow water near islands and continental land masses by means of a large encircling type of bait-net. Each haul of this net was closely observed for specimens.

3. *Examination of Stomach Contents.*

This method resulted in the collection of various surface and deep-sea forms that were not acquired in any other manner.

4. *Dip Netting Under a Night-light.*

After a day of good fishing, the tuna clippers frequently drift all night and start fishing again the next morning. This provides an excellent opportunity to suspend a bright light over the side of the vessel and dip-net the specimens attracted. Use of this method resulted in the capture of many larval and post-larval forms, as well as of the larger fishes preying upon them.

5. *Inspection of Deck.*

A walk around the deck early in the morning often produced specimens that had leaped or washed aboard the previous night.

6. *Examination of Floating Objects.*

Numerous species of fishes, including tuna, are frequently found under or in the immediate vicinity of floating objects (logs, planks, kelp and such). Tuna fishermen will often stop and throw out live bait or pick up and examine such objects, particularly if there is reason to believe they may have resulted from a shipwreck. One such pickup turned out to be a waterlogged dugout canoe containing several small fishes.

In actual practice several of the above-mentioned methods were often employed in the course of a particular evening. The night-light would be put over the side of the vessel and a dip-net made ready. Next, two handlines baited with live and cut bait, respectively, would be set out to fish. The collector would then watch for specimens to appear under the night-light, while live bait casting with rod and reel and periodically checking handlines. Situations such as this presented numerous possibilities and at times were very exciting.

LOCATIONS OF THE COLLECTING STATIONS

The magnitude of the area covered and the approximate location of each collecting station within the area are presented in Figure 1. Table 1 details collection data for all stations.

TABLE 1

Date, Location, and Collecting Method for Each Station

Station No.	Date	General locality	Latitude	Longitude	Collecting method*	Surface temp. in degrees F.	Water depth in fathoms
I	11- 7-52	Galapagos Is.	0° 48′ S.	91° 27′ W.	H, N	62	4
II	11-10-52	Galapagos Is.	1° 24.5′ S.	89° 40.5′ W.	H		
III	11-12-52	Galapagos Is.	0° 48′ S.	91° 27′ W.	H	65	
IV	11-13-52	Galapagos Is.	0° 53.5′ S.	89° 36.5′ W.	H		
V	11-14-52	Galapagos Is.	0° 39′ N.	90° 46′ W.	H		
VI	11-14-52	Galapagos Is.	0° 20.5′ N.	89° 58′ W.	L		12
VII	11-15-52	Galapagos Is.	0° 31′ S.	90° 28.5′ W.	N	71	3
VIII	11-17-52	Galapagos Is	0° 48′ S.	91° 27′ W.	N	63.5	
IX	11-20-52	Ecuador	2° 55′ S.	84° 47′ W.	D	69	
X	11-23-52	Peru	3° 31′ S.	81° 11′ W.	L	75.5	55
XI	11-27-52	Galapagos Is.	0° 25.5′ S.	91° 23′ W.	L, H	69	27
XII	11-28-52	Galapagos Is.	0° 26′ S.	91° 23′ W.	H	68	
XIII	11-29-52	Galapagos Is.	1° 32′ N	92° 13′ W.	L		
XIV	12- 4-52	Galapagos Is	0° 26′ S.	91° 23′ W.	N	69.5	
XV	12- 7-52	Galapagos Is.	1° 22′ N.	91° 50′ W.	L	78	
XVI	12-10-52	Galapagos Is.	0° 26′ S.	91° 22′ W.	N	72	5
XVII	12-14-52	Peru	3° 50′ S.	81° 11′ W.	L	72.5	
XVIII	12-16-52	Peru	3° 31′ S.	81° 11′ W.	L	76	55
XIX	12-18-52	Ecuador	2° 15′ S	81° 10′ W.	D		
XX	12-19-52	Colombia	1° 44′ N.	79° 44′ W.	L		45
XXI	12-25-52	Colombia	4° 34′ N.	77° 20′ W.	N	81	2
XXII	12-28-52	Colombia	1° 49′ N.	79° 37′ W.	S	80	
XXIII	1- 1-53	Galapagos Is.	0° 29′ S.	91° 20′ W.	N	69.5	
XXIV	1- 5-53	Peru	3° 31′ S.	81° 11′ W.	L	76	
XXV	1- 8-53	Ecuador	0° 16′ S.	80° 51′ W.	L	80.5	
XXVI	1-10-53	Colombia	2° 12′ N.	79° 00′ W.	S	80.5	
XXVII	1-17-53	Galapagos Is.	0° 27′ S	91° 22′ W.	N	77	3
XXVIII	1-25-53	Colombia	6° 24′ N.	77° 41′ W.	L	81	
XXIX	1-31-53	Costa Rica	7° 00′ N.	84° 10′ W.	H	84	
XXX	1-31-53	Panama	7° 10′ N.	82° 05′ W.	F	84	
XXXI	1-31-53	Costa Rica	7° 19′ N.	83° 39′ W.	L	84	

* H—hook and line, N—bait-net, L—night-light, S—tuna stomach contents, D—found on deck, F—floating object.

LIST OF SPECIMENS COLLECTED

By slight modification of the classification practices of the California Academy of Sciences, the following list of specimens has been arranged systematically by family and alphabetically by genus within the family. The coded numbers and letters following the scientific name of each species indicate number of specimens, station number, and collecting method, in that order. For example, "*Opisthonema libertate*—3:VII:N" means that three specimens of *Opisthonema libertate* were captured at Station VII in a bait-net. Station numbers and collecting methods are similarly marked in Figure 1.

At most of the night-light stations post-larval, juvenile, and young fish were taken. The specific identification of some of these has not yet been determined. Most of the specimens listed have been placed in the collection of the University of California, Los Angeles; others have been retained at the California State Fisheries Laboratory or have been sent to individuals or institutions specializing in a particular species or group.

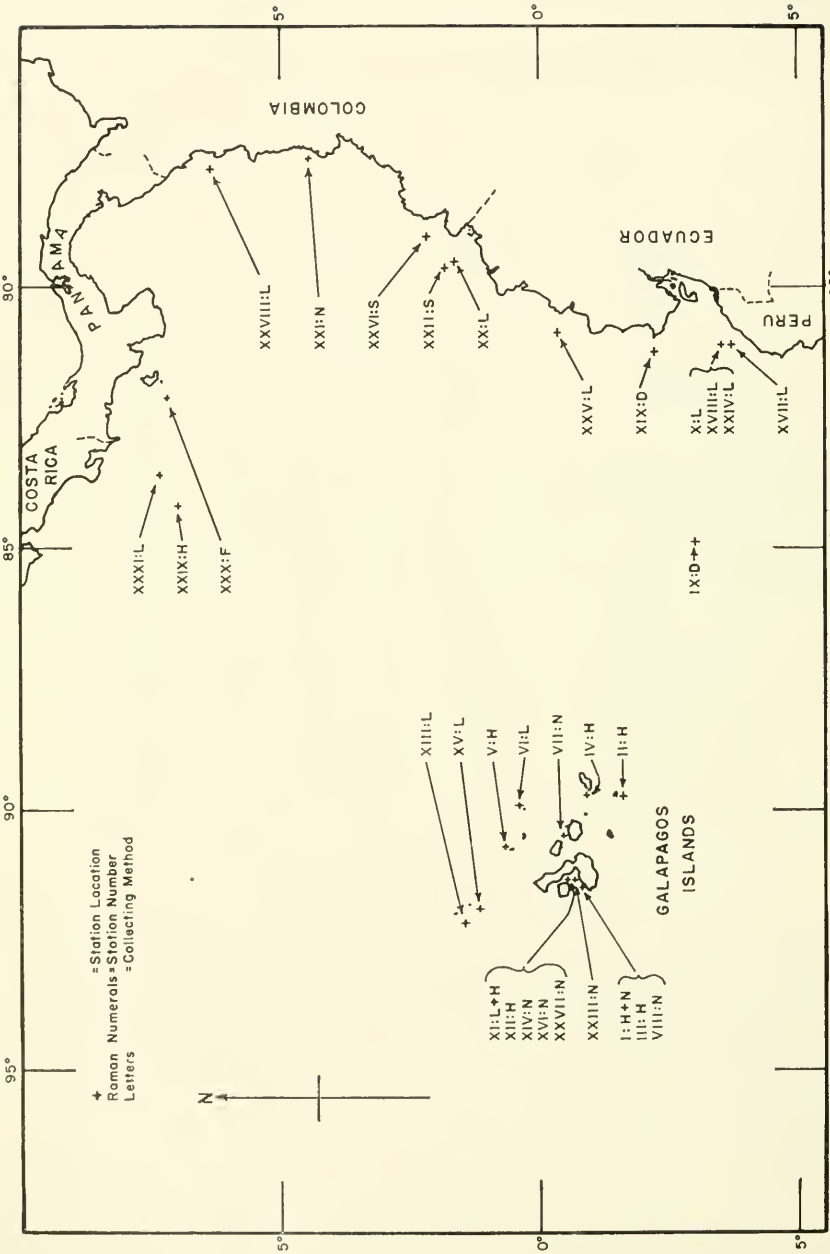

FIGURE 1. Map of the area covered during the cruise of the INTREPID, October 25, 1952, to February 11, 1953, showing collecting localities and methods.

LIST OF SPECIMENS

Clupeidae
Clupeoid larvae—3:XI:L, 2:XXVIII:L
Ilisha furthi—1:XXI:N
Odontognathus equatorialis—1:XXI:N
Opisthonema libertate—3:VII:N
Sardinops sagax—3:XXIV:L

Engraulidae
Anchoa ischana—15:VII:N
Cetengraulis mysticetus—6:XXI:N

Ariidae
Bagre panamensis—11:XXI:N
Bagre sp.—1:XXI:N

Scomberesocidae
Cololabis sp.—1:XXIV:L

Exocoetidae
Fodiator acutus—1:XXVIII:L

Synodidae
Synodus scituliceps—1:XXVII:N
Synodus sp.—1:VI:L, 2:XXIV:L

Myctophidae
Gonichthys coeco—2:XIII:L
Myctophum affine—1:XXVIII:L
Myctophum aurolaternatum—1:XXXI:L

Ophichthidae
Ophichthus triserialis—1:VII:N

Muraenidae
Muraena lentiginosa—1:VII:N

Holocentridae
Myripristis occidentalis—8:XXXI:L
Holocentrid larvae—2:XXX:F

Bothidae
Bothus constellatus—1:XXVII:N

Soleidae
Trinectes sp.—1:XXI:N

Serranidae
Diplectrum macropoma—2:XI:H
Mycteroperca olfax—2:I:H, 1:VII:N
Paralabrax albomaculatus—1:I:H, 1:II:H
Paranthias colonus—1:I:H, 1:XII:H
Prionodes fasciatus—1:VII:N

Mullidae
Pseudupeneus sp.—1:VIII:N, 1:XVIII:L, 1:XX:L, 2:XXV:L

Mugilidae
Chaenomugil proboscideus—1:XXI:N
Mugil sp.—57:XI:L, 21:XVIII:L, 1:XX:L, 19:XXIV:L, 2:XXVIII:L
Xenomugil thoburni—22:XXVII:N

Polynemidae
Polydactylus approximans—15:X:L, 1:XVIII:L, 24:XX:L, 2:XXIV:L, 1:XXV:L
Polydactylus opercularis—1:XX:L, 2:XXIV:L, 1:XXV:L

Sphyraenidae
Sphyraena idiastes—2:XXVII:N

Gerridae
Gerres cinereus—1:XXVII:N

Carangidae
Caranx sp.—1:XXIV:L, 1:XXV:L, 1:XXXI:L
Chloroscombrus orqueta—3:XXI:N, 44:XXIV:L
Decapterus sp.—1:XXIII:N
Elagatis bipinnulatus—1:XXIX:H
Naucrates ductor—1:XXIX:H, 1:XXXI:L
Oligoplites refulgens—10:XXI:N
Trachinotus sp.—1:XVII:L, 22:XVIII:L
Trachurus murphyi—1:I:N, 1:XXV:L
Zalocys stilbe—1:XXIII:N

Echeneidae
Remora remora—1:I:N, 2:VI:L

Scombridae
Pneumatophorus peruanus—30:XXIII:N

Katsuwonidae
Auxis sp.—1:VI:L, 50:X:L, 1:XVIII:L, 8:XX:L, 2:XXIV:L, 1:XXV:L, 4:XXVIII:L, 5:XXXI:L

Thunnidae
Neothunnus macropterus—2:XXVIII:L

Gempylidae
Gempylus serpens—1:IX:D, 4:XXVI:S

Trichiuridae
Trichiurus nitens—1:XIX:D

Lutjanidae
Lutjanus argentiventris—1:XXVII:N

Xenichthyidae
Xenichthys agassizi—11:VII:N, 12:XXVII:N
Xenocys jessiae—98:VII:N, 9:XXVII:N

Haemulidae
Anisotremus scapularis—2:III:H, 1:VIII:N, 2:XII:H, 3:XVI:N
Orthopristis cantherinus—35:VII:N, 1:XXIII:N, 4:XXVII:N
Orthopristis lethopristis—1:XXVII:N

Sparidae
Archosargus pourtalesi—1:VII:N, 1:VIII:N
Calamus taurinus—1:V:H, 2:XXVII:N

Sciaenidae
Larimus argenteus—6:XXI:N
Macrodon mordax—1:XXI:N
Nebris occidentalis—1:XXI:N
Odontoscion eurymesops—25:VII:N, 15:XXVII:N
Paralonchurus goodei—2:XXI:N
Stellifer ericymba—3:XXI:N
Stellifer oscitans—1:XXI:N
Stellifer zestocarus—10:XXI:N
Umbrina galapagorum—5:IV:H, 10:XXVII:N

Branchiostegidae
Caulolatilus princeps—1:V:H

Pomacentridae
Pomacentrid larva—1:XX:L

Labridae
Bodianus eclancheri—1:XXVII:N
Halichoeres dispilus—3:XXIII:N
Halichoeres nicholsi—2:XIV:N, 1:XVI:N
Thalassoma lucasanum—1:VII:N

Scaridae
Xenoscarus denticulatus—3:XXVII:N

Girellidae
Doydixodon freminvillei—1:XXVII:N

Kyphosidae
Kyphosus elegans—1:VII:N, 2:XXIX:H
Kyphosus lutescens—1:XXIX:H

Scorpidae
Sectator ocyurus—1:XXIX:H

Ephippidae
Parapsettus panamensis—1:XXI:N

Oplegnathidae
Oplegnathus insignis—3:XXVII:N

Chaetodontidae
Holacanthus passer—1:XXVII:N

Triglidae
Prionotus miles—1:IV:H

Uranoscopidae
Katheostoma averrunculus—1:XXVI:S

Callionymidae
Callionymus sp.—several:XXVI:S

Clinidae
Labrisomus jenkinsi—1:XVI:N
Malacoctenus sp.—1:XVI:N

Blenniidae
Blenny larvae—1:XV:L, 1:XXX:F
Ophioblennius steindachneri—1:VII:N, 1:XVI:N

Brotulidae
Brotula clarkae—3:XXII:S

Balistidae
Canthidermis adspersus—1:XXIX:H
Melichthys radula—1:XXIX:H
Balistid—1:XXX:F

Tetraodontidae
Sphaeroides annulatus—1:VII:N

ACKNOWLEDGMENTS

I wish to thank the following people for their contributions to this report: Mr. Art Ulrich, Captain of the M. V. INTREPID, and his crew, who furnished equipment and made this cruise a pleasure; Mr. Wayne Baldwin, who accompanied me on this cruise and assisted in the collecting of these specimens; Mr. John Fitch, who suggested that this collection be made, identified and distributed the majority of the specimens, and aided materially in the preparation of this paper.

EARLY DEVELOPMENTAL STAGES OF THE CALIFORNIA BARRACUDA, *SPHYRAENA ARGENTEA* GIRARD[1]

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The California barracuda, *Sphyraena argentea* Girard, is a major commercial and sport fish along the coasts of Southern California and Baja California, but there are still many gaps in our knowledge of its early life history. Barnhart (1927) figured and briefly described the egg and newly-hatched larva, and Walford (1932) treated the spawning season and certain aspects of growth and maturity. Little additional information on this species has been published. Recent studies at Scripps Institution have shown the need for a more complete description of the egg and larval stages, to permit accurate recognition of barracuda material in plankton samples. As discussed below, it is thought that Barnhart's specimens were correctly identified but that his method of preservation obscured some important diagnostic characters. In the present paper the early developmental stages are described from studies on both living and formalin-preserved samples. Identification was established by the diagnostic somite count and by rearing larvae for several days after hatching, at which time they were unmistakably conspecific with small specimens in a graded series of postlarvae and juveniles in the collection of Scripps Institution.

EGGS

The pelagic eggs of *Sphyraena argentea* were described by Barnhart (1927) as "transparent; diameter 1.02 mm.; one oil globule, brownish, .20 mm. in diameter; zona radiata finely striated, covered with fine dots; yolk homogeneous. Perivitelline space small if any; embryo almost completely in contact with inner surface of envelope." Walford (1932) recorded the mature ovarian eggs as 1.14 to 1.6 mm. in diameter.

Eggs of the barracuda that I have studied, from fresh plankton samples off La Jolla, measure about 1.5 mm. in diameter. In early embryonic stages the egg is commonly slightly lopsided rather than fully spherical. In life, the capsule lacks any obvious texture, but some preserved eggs show a very minutely striated surface. The yolk of live eggs is colorless and very distinctly alveolar ("segmented"), the oil globule colorless or very pale buff. Preservation makes the yolk somewhat opaque, and its alveolar nature is then difficult or impossible to observe. The yolk texture is, therefore, a useful supplementary character for the recognition of live eggs of the barracuda, but it is of little value for the identification of this species in preserved samples.

[1] Submitted for publication September, 1954. Contributions from the Scripps Institution of Oceanography, New Series, No. 770.

EMBRYONIC DEVELOPMENT

Barnhart did not mention pigment in the embryonic stages of the barracuda, and credited the newly-hatched larva with only two yellowish chromatophores. In reality, the advanced embryonic stages are heavily marked with both black and yellow cells, which have a well-defined migratory history and form distinctive patterns that greatly assist identification. The yellow cells fade after preservation but, for the sake of taxonomic completeness, this pigment is described in the stages for which live material has been available. The black pattern persists in specimens that are properly preserved.

The youngest pigmented embryo that I have seen thus far (Figure 1, A) had the embryonic axis well developed, and had a short tail bud. At this stage small black cells are abundant on the dorsal and dorsolateral surfaces. Anteriorly, the pigmented area divides into two dorsolateral bands that rejoin transversely across the posterior part of the midbrain, leaving the area above the hindbrain free of pigment. There are a few black cells over the ventro-lateral surfaces of the tail somites, and a few extend down the posterior surface of the yolk sac toward the level of the oil globule.

In a slightly more advanced embryonic stage, examined alive, the tail bud is longer and its median fin folds are somewhat better defined, though they are still simple ridges. Melanophores more extensively invade the sides of the somites and extend back along both dorsal and

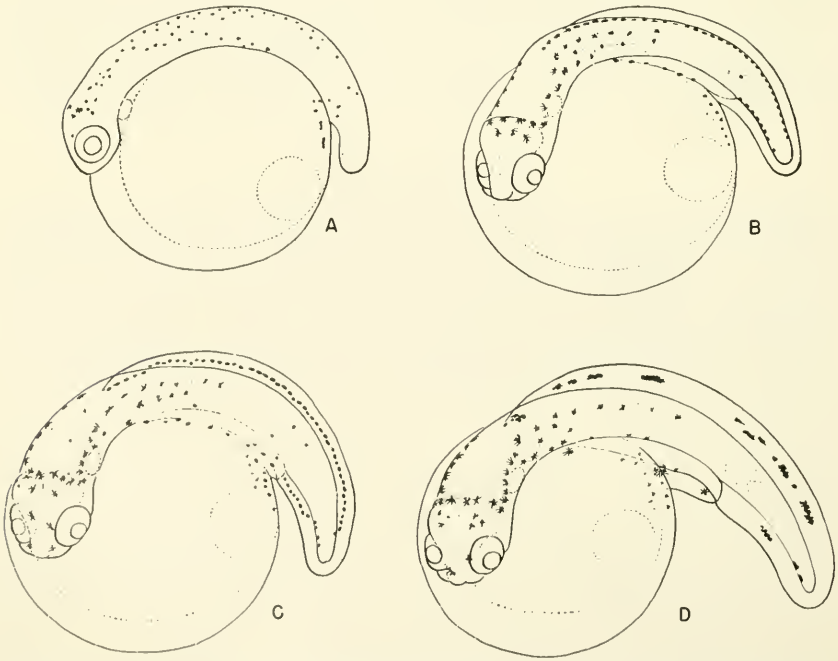

FIGURE 1. A, B, C, D—Embryonic stages (egg capsules omitted). This figure is based on preserved eggs, and thus the yellow pigment and yolk texture are not shown. B, C, and D are drawn in the same standardized position, to simplify comparisons.

ventral surfaces of the tail bud. The dorsal pattern on the "neck" (the area between the midbrain and the pectoral region) has simplified into a diagrammatic shield-like design (as in Figure 1, B, C, D). The black cells on the posterior surface of the yolk sac are in an irregular, more or less double, row. There are no melanophores on the oil globule. In addition to the black pigment this stage has, in life, a conspicuous yellow pattern, which is pale yellow in reflected light and brownish orange-yellow in transmitted light. The yellow cells are distributed in blotches and irregular patches, chiefly as follows: one or more behind each eye; several scattered irregularly along the dorsal and dorso-lateral surfaces of the body; an irregular band along the ventro-lateral surfaces of the somites, approximately in the pectoral region; a pair of dorso-lateral and a pair of ventro-lateral blotches just posterior to the base of the tail bud; and a patch on the postero-ventral surface of the yolk sac, over the region of the oil globule.

In successively more advanced embryos (Figure 1, B, C, D) the tail lengthens and its median fin folds expand, and the gut lengthens until it extends a moderate distance beyond the posterior surface of the yolk sac. Concurrently, the melanophore pattern undergoes a conspicuous sequence of changes. The pattern on the "neck" remains simple and diagrammatic. Posterior to it melanophores assemble in a sharply defined mid-dorsal line along the base of the developing dorsal fin fold, and a similar mid-ventral line of melanophores assembles along the base of the ventral fin fold (Figure 1, B). As the fin folds enlarge, the median lines of black cells move out into the respective dorsal and ventral folds. Here they at first retain their linear alignment (Figure 1, C), but then aggregate into a series of disconnected blotches (Figure 1, D). On the basis of present knowledge, it is not clear whether the movement of melanophores into the fin folds results from active migration or whether the cells might be transported passively along with the outward growth of connective tissue that forms the fin folds. The preliminary movement of the melanophores onto the mid-dorsal and mid-ventral lines (particularly the latter) probably results from active migration.

Before hatching, the prolarval pigmentation (described in detail below) is essentially complete. Particularly distinctive are the dark blotches in the fin folds, the pattern on the neck, and the failure of the oil globule to acquire a cap of melanophores. A similar pattern on the neck is recognizable in embryos of various other fishes, but in the barracuda it is unusually diagrammatic and is retained into more advanced developmental stages than in any other form that I have studied thus far. Likewise, development of black pigment in the median fin folds is not unique to the barracuda, but in the particular details of this pattern sequence the barracuda differs from other California fishes that have been described thus far.

The eggs and larvae on which Barnhart based his brief description were probably correctly identified. His outline drawing of the newly hatched larva, apparently guided by a camera lucida, is essentially correct in morphological features, including the unusual combination of somites (14+11) that characterizes the barracuda. The most conspicuous discrepancy is in pigmentation, and this can probably be

attributed to the effects of preservation. Barnhart's specimens have not been located, so it is not known whether they were preserved in Bouin's solution or in weak formalin. Bouin's is a common embryological preservative, and Barnhart is known to have used it in some cases, but its property of fading melanin makes it undesirable for use with materials that are intended for taxonomic study. Weak formalin, 5 percent or less, is a poor fixing solution for fish eggs and larvae; it not only fails to retain the black pigment adequately but does not preserve morphological characters properly, and produces soft, fragmented specimens. The use of 10 percent formalin is strongly advised. Standard plankton samples preserved in this way remain in excellent condition for study. Embryos and larvae of the barracuda preserved in 10 percent formalin in 1951 and 1952 still retain their melanophore patterns; others that were preserved in weak solutions now show little or none of the diagnostic pigmentation and, in addition, their morphological characters are poorly preserved.

THE PROLARVAL STAGE

The prolarval stage is defined as that part of larval development between hatching and the complete disappearance of the yolk sac (Hubbs, 1943). In the California barracuda, this stage lasts about three or four days under laboratory conditions.

Barnhart (1927) reported the prolarva of the barracuda to have " * * * a large globular yolk-sac; total length, 2.25 mm.; length, snout to anus, 1.50 mm.; anus, one-third the distance from posterior edge of yolk-sac to end of caudal fin. Pigmentation very scarce; two yellowish chromatophores, one just above anus, and above it a larger one on the dorsal surface."

The characters of the newly hatched larva and the subsequent changes during the brief prolarval period are here redescribed from fresh material. The descriptions are based on living specimens except where otherwise stated. The yellow pigment cells and the alveolar structure of the yolk are conspicuous in life and contribute to a well-rounded knowledge of the taxonomic characters of this species, but both features are lost more or less completely in preserved specimens, and hence are of limited usefulness for the identification of preserved plankton.

The *recently hatched prolarva* (Figure 2, A) is about 2.5 mm. long. The large ovoid yolk sac is colorless and transparent, with distinct alveolar or "segmented" structure. The posteriorly placed oil globule is colorless or pale buff. The head is still embryonic; the eyes and ear capsules are conspicuous, but the jaws have not yet formed. The pectoral fin buds are very small. The moderately long gut extends well posterior to the end of the yolk sac. Median fin folds are well developed; the dorsal fold begins above or slightly behind the midbrain, and there is a moderately long preanal fold. The somites typically number 24 or 25 (14 on the body, 10 or 11 on the tail). Both black melanophores and yellow cells are abundant. The yellow cells are aggregated in blotches, chiefly as follows: one behind each eye; a pair on or near the prospective jaw position; two pairs along the ventro-lateral surfaces of the trunk somites, respectively anterior and

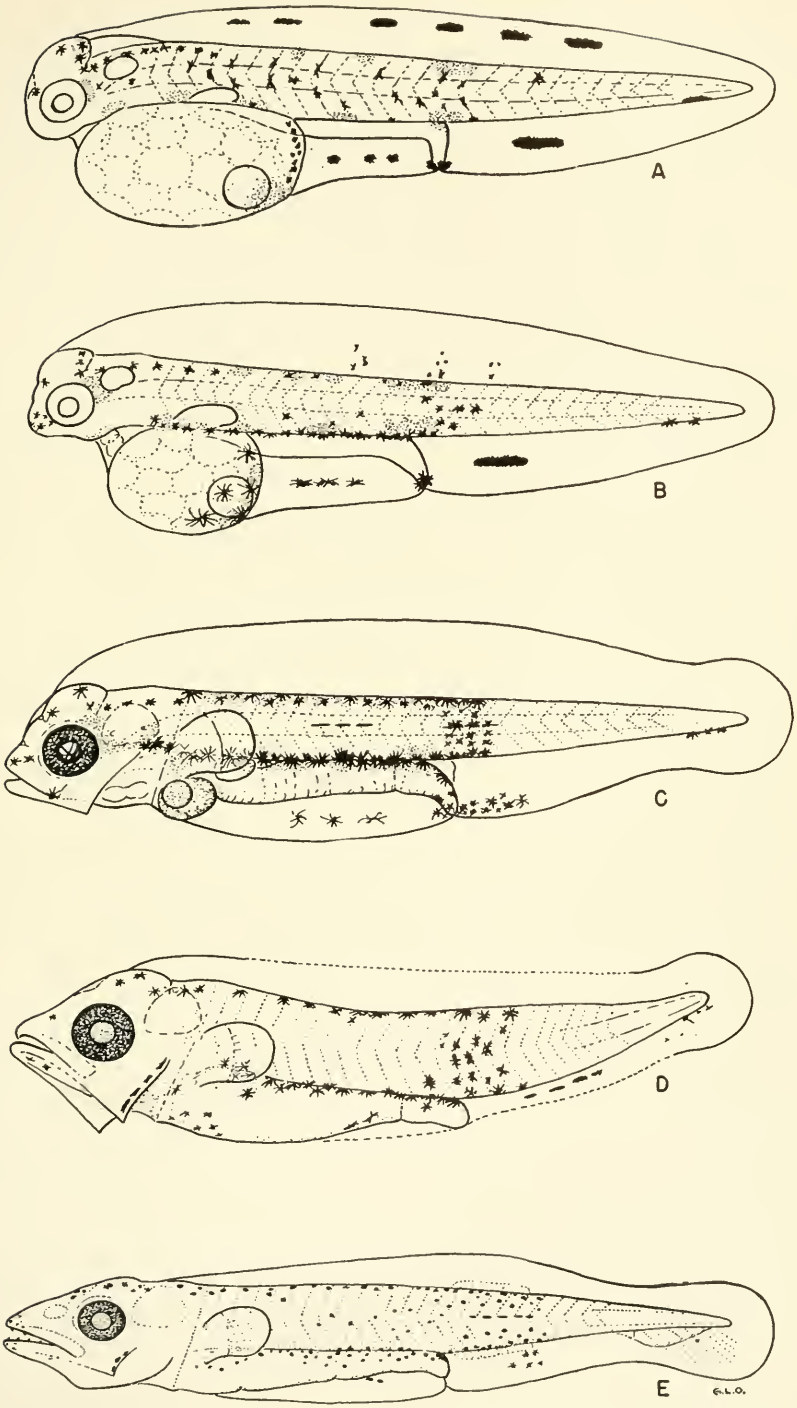

FIGURE 2. A—Recently hatched larva. Total length about 2.5 mm. A, B, and C are based on live specimens, and thus show the areas of yellow pigment (represented as stippled blotches) and the alveolar structure of the yolk. B—Larva one day after hatching. C—Larva three days after hatching. D—Larva about 4 mm. in total length. E—Larva about 7 mm. in total length.

posterior to the pectoral fin buds; a pair of large blotches above the angle of the hindgut, and above them a large mid-dorsal blotch on the top of the somites at the base of the tail; an additional yellow patch on the yolksac over the region where the oil globule adjoins its surface; a few small yellow spots are variously scattered along the back. The pattern of black cells provides a *combination* of characters conspicuously unlike that of known prolarvae of other local fishes. The neck bears a pair of dorso-lateral rows of black cells that join across the back of the midbrain, leaving the top of the hindbrain conspicuously free of pigment; along the sides of the body amoeboid black cells are conspicuously associated with the myocommata, along which they are apparently migrating. An irregular double row of black cells extends down the posterior surface of the yolk sac to the level of the oil globule. The median fin folds are conspicuously marked with black blotches; they vary somewhat in number and arrangement, but typically the preanal fin fold has from one to three, the ventral fin fold usually a single blotch, and the dorsal about six, some of which may be more or less confluent. There are scattered melanophores on the snout, along the gut, in the anal region, and in a ventral blotch near the tip of the tail. The oil globule lacks black pigment.

The *day-old larva* (Figure 2,B) shows conspicuous changes but is still in a very embryonic condition. The yolk sac is reduced and more rounded; it is now entirely posterior to the head and is only about half the length of the gut. The yolk is still conspicuously alveolar. The head is somewhat larger, the snout projects slightly, and the jaw rudiments form a distinct bulge on the lower surface. The pectoral fin buds have enlarged, but are still embryonic. The pigmentation is intensified. The yellow chromatophores are now brilliant yellow-orange in both reflected and transmitted light, and the aggregations of these cells have enlarged. The yellow blotches behind the eyes and those anterior and posterior to the pectoral fin buds are paired; those along the dorsal surface of the somites are median; those along the lower edges of the posterior body somites are now apparently confluent across the median line. The pattern of black cells on the neck persists. Most of the black cells that were migrating downward along the sides of the body have reached the lower edges of the somites, and there form a dense double row; dendritic black cells have spread outward irregularly over the posterior surface of the yolk sac. Conspicuous patches of melanophores persist in the ventral and preanal fin folds, but those in the dorsal fin fold have broken up and the individual cells are withdrawing downward toward the somites. A few black cells are scattered along the mid-dorsal surface of the body somites, and a new group is assembling on the sides of the somites at the base of the tail.

The *two-day larva* (not figured) has advanced greatly. The yolk sac is reduced to a globular mass smaller than the head. The pectoral fins are functional. The ear capsules are greatly enlarged, the jaws have formed, and the snout profile slopes moderately. The large eyes are heavily pigmented. There is a pair of large yellow blotches behind and internal to the eyes, a pair on the lower edges of the somites in the pectoral region, about three large and more or less confluent me-

dian blotches along the top of the gut, and about three long, vaguely defined yellow bars along the top of the body somites. The embryonic pattern of black cells on the neck persists, but is variably distinct, depending on whether the pigment in the cells is dispersed or concentrated. A double row of large, closely spaced melanophores extends along the top of the gut. A moderate number of smaller black cells is scattered along the dorsal and dorso-lateral surfaces of the body, and a diffuse band of black cells encircles the base of the tail. The dorsal fin fold is now free of black pigment, or has only one or two stray cells, but aggregations of black cells persist in the preanal and ventral fin folds. The pectoral fins are unpigmented. A few melanophores dot the surface of the snout, and there are a few internally in the snout, apparently underlying the forebrain.

The *three-day larva* (Figure 2, C) still has the greatly reduced oil globule and a small remnant of the yolk sac. The snout profile slopes moderately. The well-developed jaws are snapped occasionally, and the larva sometimes bends into an S-curve and then darts forward abruptly, as though pouncing on something. These activities are doubtless preliminary to feeding behavior, though I have not observed actual feeding at this stage. The air bladder is clearly visible; the gut is enlarged and has thickened, annulated walls. The somites typically number $14 + 10 = 24$, agreeing with the vertebral count of the adult (Clothier, 1950). The basic color pattern is little changed, but the colors and the pattern are somewhat intensified; this is especially true of the pigment centers along the dorsal surfaces of the body, the top of the gut, and the band around the base of the tail. In addition to black and yellow cells, the dorsal surfaces of the body and the base of the tail now bear iridescent coppery-greenish or bluish pigment (probably guanine). This combination of colors gives the living larva a distinctly greenish or bluish sheen macroscopically.

Larvae *four days old* are capable of feeding, and one was observed to feed heavily on nauplii of the brine shrimp, *Artemia salina*. It seems probable that, with reasonable care, barracuda larvae could be reared in the laboratory, at least through the earlier postlarval stages.

As in many other marine fishes that have small pelagic eggs, the chromatophores of the California barracuda develop pigment quite early, and part of the migratory history of these cells can be traced readily in the embryos and larvae. Of particular interest in this species is the complex sequence of cell movements involved in the formation and subsequent partial withdrawal of the pattern in the fin folds. A general discussion of pigment cell migration and early pattern formation in fishes has been given elsewhere (Orton, 1953). An understanding of how the extensive pattern changes of young fishes take place enables one to interpret differences and resemblances in these pigment characters more critically and to use them more effectively in identification, especially in piecing together conspecific series of developmental stages from the very heterogeneous material in plankton samples. On a small scale, this illustrates the value of basic research in paving the way for the improvement of applied techniques.

EARLY POSTLARVAL STAGES

The fish collection at Scripps Institution contains a number of postlarvae and juveniles of *Sphyraena argentea*. The smaller specimens are only slightly more advanced than three- and four-day-old larvae reared from eggs, and they grade into juveniles of unquestionable identity. Two small postlarvae are described here. Both are somewhat distorted as a result of preservation, and their length measurements are approximate.

Four mm. larva (Figure 2, D). This specimen now measures about 3.5 mm. in total length, but the somites are greatly contracted and the actual total length was probably about four mm. in life. There are about 14 somites on the body, about 10 on the tail. The head is moderately large, the strongly developed jaws are pointed and protrude somewhat, and the angle of the lower jaw is sharply pointed. The small pectoral fins are not yet rayed, and there are no pelvic fin buds. The median fin folds, which are still simple, are damaged and their extent is somewhat uncertain; the dorsal fold arises on the midbrain, and there are still traces of a preanal fold. The gut is moderately long, straight posteriorly. The melanophore pattern is still much like that of the three-day larva. Large melanophores are closely crowded along the dorsal surface of the body and the base of the tail. Anteriorly, the pattern forms two dorso-lateral lines of melanophores that continue forward lateral to the hindbrain and join transversely across the rear edge of the midbrain. This linear arrangement on the neck persists from the embryo with little change, an unusually long retention of an embryonic pattern element. Black cells are numerous along the top of the body cavity, and a conspicuous band of them encircles the base of the tail. There is a large median black cell on the forebrain, a few small ones on the snout and jaws, and a row margins the posterior angle of the jaw. The ventral fin fold bears a group of black cells at the mid-tail level, and a few enter the fin fold at the tip of the notochord. A few additional black cells are variously scattered over the belly and throat. The pectoral fins still lack pigment.

Seven mm. larva (Figure 2, E). This small, moderately slender, narrow-headed larva already resembles juvenile stages of the barracuda quite strongly, especially in the contours of its rather narrow, beak-like jaws. The angle of the lower jaw is very sharply pointed and its concave posterior margin is edged with confluent melanophores. The gut is moderately long, and is straight posteriorly. The pectoral fins are still simple, nonrayed, and the pelvics have not yet appeared. Basal elements of the anal (nine) and second dorsal (count uncertain) fins are forming, and hypural and caudal ray rudiments are present, but the tip of the notochord is still straight. The median fin folds are still moderately high; the dorsal fold begins above the hindbrain, and the preanal fold extends forward nearly to the pectoral region, as in earlier stages. The principal aggregations of black pigment cells that formed in early stages are still recognizable, but the originally sharp outlines of these pattern elements are now somewhat blurred by the increased abundance of pigment cells. The dorsal fin fold is unpigmented, the preanal fold has two small melanophores, and the ventral fold has about six. There are moderate numbers of small melanophores on the

top of the head, along the dorsal surfaces of the body and anterior half of the tail, and along the upper sides of the belly. There are a few on the sides of the body somites. The basal half of the tail is more heavily pigmented with surface melanophores than in earlier stages, and in addition its mid-lateral septum bears a short row of linear cells. A few black cells occur around the tips of the jaws.

COMPARISONS

The developmental characters of Pacific Coast fishes are still too incompletely known to permit adequate listing and discussion of species with which the eggs and larvae of *Sphyraena argentea* might be confused. Hence, no extensive comparisons are attempted in this paper.

Advanced embryos and prolarvae of carangid fishes share with the barracuda the characters of alveolar yolk, moderately long gut, and somewhat similar body pigmentation, but carangids differ in having the oil globule in the anterior end of the yolk sac and capped with melanophores, fin folds without black patches (but commonly with *yellow* patches in life), no band of melanophores encircling the base of the tail, different somite count, and other differences in structure and pigmentation.

Walford (1932) noted that little has been published on the biology and life history of any of the barracudas of the world. Judging from experience with other groups of fishes, it may be expected that in general the early stages of the various barracudas will show a close group resemblance in basic morphological characters and probably in certain features of pigmentation. In a preliminary search of the literature I have found information on early stages of only one other species of barracuda, *Sphyraena sphyraena* Linnaeus in the Mediterranean (Vialli, 1937; Plate 35). This plate figures 11 stages, in color. It is accompanied by captions, but there is no descriptive text. The figured stages are chiefly juveniles, but there are four larvae, ranging from an advanced prolarva about 4 mm. long to a postlarva about 6 mm. long. These larvae fall between various stages of *S. argentea* that I have seen, but they correspond sufficiently to permit useful comparisons. There is a close agreement between the two species in general morphological characters and in some of the basic features of pigmentation, and there are differences in details that are probably of specific value. The two forms agree in early development of heavy pigmentation along the upper and lower surfaces of the body somites and the top of the body cavity, and in the presence of black pigment in the median fin folds in early stages and its reduction or loss in later stages. On the basis of this plate, *S. sphyraena* appears to differ from *S. argentea* in the extension of heavy dorsal and ventral pigmentation farther backward along the tail, nearly or entirely to the future base of the urostyle; the development of a mid-lateral line of melanophores along most of the length of the tail rather than a band of cells encircling the base of the tail; the presence of a mid-ventral line of black pigment from pericardium to anus; and the retention of the fin-fold pigment in series of small and rather evenly-spaced black dots (individual melanophores?) in contrast to its aggregation into blotches in *S. argentea*.

These differences suggest possible trends of larval variation to be expected in other barracudas. There is apparently nothing known concerning the early stages of the other eastern Pacific forms. Fowler (1944) listed only two; *S. ensis* Jordan and Gilbert (type locality, Mazatlan) and *S. idiastes* Heller and Snodgrass (type locality, Galapagos). However, Mr. John E. Fitch informs me that the dominant barracuda in the Gulf of California is an undescribed species, under study by Dr. George S. Myers, and that the range of this new form extends northward outside the Gulf at least to Cedros Island. Between San Juanico Bay and Cedros Island, at least, it overlaps the southern limits of the California barracuda. It would be useful to know how to separate these forms in early developmental stages. Toward this objective, sphyraenid eggs and larvae should be watched for in plankton samples taken along both the Pacific and Gulf sides of Baja California.

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ON RECENT CALIFORNIAN OCCURRENCES OF THE RARE OCTOPOD *OCYTHOE*[1]

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Ocythoe tuberculata Rafinesque is a more heavy-bodied, more gigantic relative of the argonaut, or paper nautilus. In general aspect it suggests not only the argonaut itself but its more distant kinsman the common octopus in a much clumsier development. It is a creature of most striking appearance and has long been known to frequenters of the sea, particularly the Mediterranean, yet it can apparently nowhere be regarded as common. Indeed Robson, in his monograph of the Octopoda (1932:p.202-203), records a total of only 14 specimens (half of them without locality data) then in the British Museum and a similar number in the Paris Museum, and these must be about the two best equipped collections of these animals. Besides the Mediterranean, which has been the source of nearly all known examples, we find the species recorded from Madeira, the northeast Atlantic, the West Indies, Vineyard Sound, Massachusetts, and Japan, whence several zoologists have reported it.

Nearly 40 years ago a fair-sized female *Ocythoe* was captured near Avalon, Santa Catalina Island. In due course this specimen came into the possession of Dr. William A. Hilton of the Department of Zoology of Pomona College, who presented it to me. It was duly reported upon in print (Berry, 1916:p.1-4, fig.), and is still in my possession and in good condition. For many years it remained altogether unique, but either a renewed influx of the species has taken place in our waters or more attention is now being paid to the capture of such animals, as within the past two or three years no less than seven additional examples, all females, have been taken in local waters and submitted to me for determination (Table 1). As is manifest from Table 2, these comprise a valuable and illuminating series of growth stages, ranging from a juvenile specimen with a mantle length of only 16 mm. [1030] to the sturdy mid-channel example [1027], which has a dorsal mantle length of 157 mm. and is the second largest thus far captured in Californian waters. All of the more juvenile examples examined were taken from stomachs of Pacific lancetfish (*Alepisaurus borealis*), which are thus shown to prey upon *Ocythoe* of manageable size, as they do upon the paper nautilus, *Argonauta*, and various other species of pelagic or nectonic cephalopods. That they were ingested in the immediate area where the lancetfish were captured is indicated by their unmacerated condition and generally excellent preservation.

The recorded captures of *Ocythoe* are both localized and scattered but are indicative of a very wide range. Although as yet no one has been able to discover grounds for the recognition of more than the

[1] Submitted for publication January, 1955.

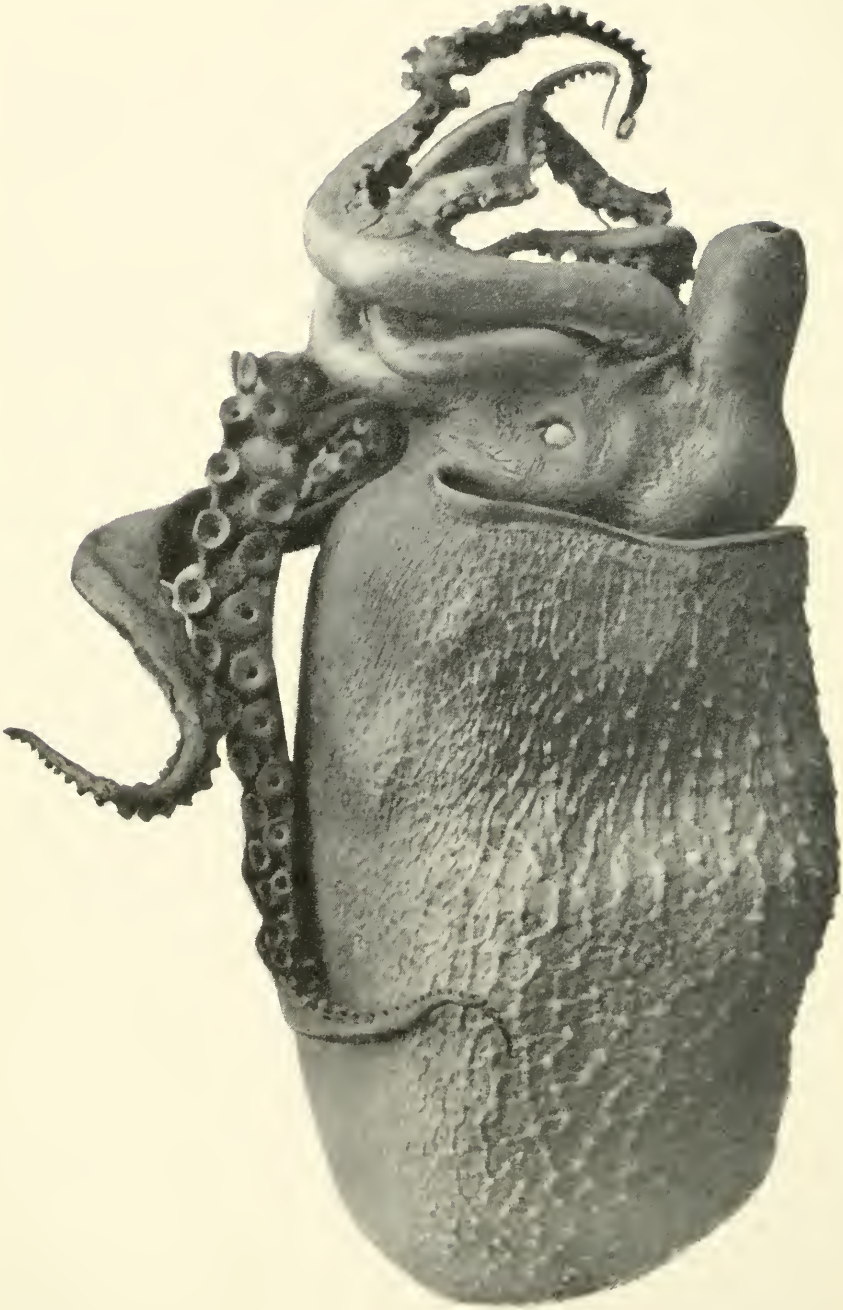

FIGURE 1. *Ocythoe tuberculata* Rafinesque. Female taken near Avalon, Santa Catalina Island, California [453]. A little over five-eighths natural size.

TABLE 1

Material Examined

Number of specimens	Sex	Locality	Method of capture	Collector or station	Date	Register number
1	♀	Near Avalon, Santa Catalina Island, Calif.	?	W. F. Hamilton	Summer 1915	[153]
1	♀	Mid-channel, off San Pedro, Calif.	Hook and line	Dearden's Fish Mkt.	July 25-26, 1953	[1027]
1	Juv. ♀	10 mi. south of San Pedro breakwater, Calif.	Gill net	Anthony and Dick Cresci, on GIOVANNI	April 23, 1953	[1026]
1	♀	Lat. 31° 55′ N., long. 118° 20′ W., off nor. Baja Calif.	Plankton haul	HORIZON H-13-97.50, Scripps Inst. Oceanog.	April 15, 1950	[1025]
1	Juv. ♀	Lat. 34° 00′ N., long. 131° 55′ W., W. of Southern Calif.	Stomach of *Alepisaurus*	N. B. SCOFIELD Sta. 54S-1-11	Jan. 18, 1954	[1029]
1	Juv. ♀	Lat. 31° 51′ N., long. 136° 55′ W., W. of Southern Calif.	Stomach of *Alepisaurus*	N. B. SCOFIELD Sta. 54S-1-22	Jan. 31, 1954	[1030]
2	Juv. ♀ ♀	Lat. 35° 05′ N., long. 136° 55′ W., W. of Southern Calif.	Stomach of *Alepisaurus*	N. B. SCOFIELD Sta. 54S-1-24	Feb. 2, 1954	[1031]

TABLE 2

Measurements of **Ocythoe tuberculata**, in Millimeters

	[1030] ♀ Juv.	[1031] ♀ Juv.	[1031] ♀ Juv.	[1029] ♀ Juv.	[1026] ♀	[1025] ♀	[1027] ♀	[453] ♀
Total length	67.0	76.0	107.0	153.0	203.0	235±	415±	440.0
Length of body, dorsal	17.0	18.0	25.0	41.0	56.0	80.0	150.0	160.0
Tip of body to interocular line	18.0	19.0	27.0	43.0	60.0	86.0	154.0	160.0
Tip of body to base of dorsal arms	20.0	20.0	28.0	46.0	63.0	90.0	164.0	170.0
Maximum width of body (first four widest anteriorly)	11.0	10.0	17.0	26.0	38.0	65.0	100.0	115.0
Width of nuchal commissure	8.0	8.5	15.0	17.0	24.0	45.0	57.0	55.0
Width of head at eyes	11.0	11.0	17.0	24.0	30.0	48.0	73.0	74.0
Length of funnel (ventro-median)	13.0	13.0	17.0	24.0	30.0	41.0	80.0	60.0
Mouth to tip of right dorsal arm	42.0	51.0	75.0	100.0	138.0	155.0	265.0	275.0
Mouth to tip of left dorsal arm	42.0	45+	78.0	109.0	138.0	148.0	265.0	265.0
Mouth to tip of right second arm	23.0	28.0	49.0	70.0	86.0	108.0	192.0	200.0
Mouth to tip of left second arm	23.0	27.0	48.0	65.0	81.0	113.0	185.0	195.0
Mouth to tip of right third arm	21.0	24.0	44.0	57.0	71.0	103.0	182.0	180.0
Mouth to tip of left third arm	3+	24.0	41.0	59.0	75.0	102.0	173.0	185.0
Mouth to tip of right ventral arm	16+	48.0	83.0	99.0	132.0	155.0	175+	250.0
Mouth to tip of left ventral arm	47.0	51.0	79.0	100.0	128.0	150.0	125+	240.0
Diameter of one of largest suckers	1.4	1.5	2.0	3.0	4.0	5.0	7.0	9.0

single species, it must be recognized that no student of the genus has ever possessed material from outside his own area of investigation sufficient to permit direct comparison of comparable series. Oceanic species are notoriously wide-ranging and prone to exceeding weakness in speciation. Hence racial differences, even when present, as appears by no means to be invariably the case, often require particularly intensive study to detect and establish. One of the most complex organs possessed by *Ocythoe*, and hence one which might reasonably be expected to reveal racial differences if any structure is to do so, is the very elaborate hectocotylus or sexually modified right third arm of the male. Unfortunately all of the Californian specimens so far known are females and in the mantle cavity of none that I have examined to this end have I been so fortunate as to find a free hectocotylus, although I have repeatedly so found one or more in *Argonauta*. No present help in answering the question of possible racial differentiation therefore stems from this source.

The curious tuberculated ventral reticulation which forms so conspicuous a feature of the mantle of adult females is weaker in less advanced stages of development, yet its beginnings are clearly to be made out in quite young animals. A more conspicuous difference between youth and maturity lies in the length of the arms relative to the body, for in juvenile specimens these are proportionately longer and more octopus-like.

Observation of the locomotion of a female *Ocythoe* might be of considerable interest. Although, as shown in the illustration, the animals are far from streamlined, the tremendous development of the funnel (one of the largest if not the largest known in cephalopods), the muscular mantle, and the strongly developed cartilages which insure tight locking of the pallial margin to the head as the pallial muscles contract, all indicate great power in the expulsion of water from the pallial chamber. [2]

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[2] While this paper was in press, and hence too late for inclusion in the tables, a ninth example of *Ocythoe tuberculata* has come to hand. This is a well preserved female having a dorsal mantle-length of approximately 163 mm., and a maximum longitudinal extension of 450 mm. It thus becomes the largest so far recorded for this area. It was taken in a purse seine at night, Feb. 16, 1955, 2 mi. north of the north end of Guadalupe Island, Baja California, by Ben Fukuzaki (Boat STELLA MARIS), to whom I am indebted for the carefully cared for specimen.

THREE PROTOZOAN DISEASES OF TROUT IN CALIFORNIA[1]

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These notes will serve to record three protozoan diseases which have been found in rainbow trout and certain other species of fishes in California during the past nine years. At a later date this record will be followed in this or other journals by more complete descriptions.

All three of these diseases are important in trout hatcheries of the California Department of Fish and Game and two of them are probably of considerable importance in wild salmonid populations in the State.

The life histories of the protozoa involved are incompletely known and their full importance in the trout hatcheries and in the wild is little understood. However, the writers believe that the diseases which they cause may be among the most important protozoan diseases of trout in California and as such warrant further study.

Class Mastigophora
Order Protomonadina
Cryptobia borreli (Laveran and Mesnil)

Occurrence. In the six years that this hemoflagellate has been studied by the writers it has been found in several species of fishes. It was first observed in 1949 in domesticated, fall-spawning rainbow trout, *Salmo gairdneri*, at Mt. Shasta Hatchery, Siskiyou County. In the same year it was found in a group of yearling king salmon, *Oncorhynchus tshawytscha*.

During the period 1950-52 the writers, with the aid of Mr. E. R. German of the Department of Fish and Game, found *Cryptobia* in the following wild fishes of the Klamath and Sacramento river drainages of northern California: steelhead rainbow trout, *S. gairdneri gairdneri*; brown trout, *S. trutta*; king salmon, *O. tshawytscha*; silver salmon, *O. kisutch*; Klamath large-scaled sucker, *Catostomus snyderi*; sculpin, *Cottus* sp.

Epidemiology. This parasite occurs at Mt. Shasta Hatchery in both yearling and adult rainbow trout. It is not known to have occurred in epizootic proportions, but it is believed that many post-spawning losses in rainbow brood fish have been due to the combined effects of *Cryptobia* and the secondary invader *Saprolegnia parasitica*.

When king salmon were held to yearling age at Mt. Shasta Hatchery they proved to be exceptionally vulnerable to *Cryptobia* infections and suffered high mortalities. No secondary invaders were involved in these cases.

[1] Submitted for publication March, 1955.

The role of this parasite in wild fish populations is little understood. Blood smears collected in the field from several fish which were obviously sick showed them to be infected. Smears from fish which were apparently healthy showed many of them to be lightly infected. Further work will be required before the extent of losses in wild populations is known. However, it was found that 1.5 percent of 127 blood smears from adult king salmon were positive. Of seven smears from wild, adult steelhead rainbow, three were positive. Of 129 smears from steelhead yearlings and two year olds, 39 percent were positive. Only eight silver salmon yearlings were examined, but smears proved two of them, which were behaving abnormally, to be heavily infected with *Cryptobia*.

Various species of leeches are reported to be the vectors of cryptobids (Wenyon, 1926). The present writers found several leeches (*Piscicola salmositica*) harboring *Cryptobia* in the gut. Multiplicative phases were not demonstrated, however.

Pathology. The site of cryptobid infections in fishes is reported by Wenyon (1926) to be the blood and the intestinal canal. Heavily infected king salmon yearlings at the Mt. Shasta Hatchery were found to have these protozoans in the skin, in the blood, and in the ascitic fluid of the abdominal cavity. Tissue sections further revealed these parasites in the myocomma and connective tissue of the muscle bundles. Sections of the kidney showed the flagellates in the parenchyma. No forms were found in the intestinal canal.

Severely infected fish were found to be anemic and their gills were covered with a whitish, translucent, gelatinous exudate. The blood clotting time appeared to be greatly reduced. In fish which had large numbers of *Cryptobia* in the skin, the scales were raised, giving the surface a rough appearance. Abnormal amounts of mucus were present on the surfaces of such fish. The viscera of infected fish appeared normal, except for a slight paleness of the liver.

Externally, the heavily infected hatchery rainbow trout exhibited marked exophthalmia, distended abdomens, raised scales, and varying degrees of anemia. Such fish were lethargic and abnormally dark.

Class Sporozoa
Order Microsporidia
Plistophora sp.

Occurrence. It is not known at the time of writing whether or not this is an undescribed species. Indications are that it is new, since this is the first time a microsporidian is known to have occurred in any member of the family Salmonidae.

The protozoan which is here recorded for the first time was identified in 1954 as a microsporidian from advanced fingerling trout of wild steelhead rainbow stock, *S. g. gairdneri*, at Darrah Springs Hatchery, Shasta County. Soon afterward it was found in advanced fingerlings of wild, British Columbia rainbow stock, *S. g. kamloops*, at Darrah Springs Hatchery. It has since been found in several other trout hatcheries in California and in several wild trout populations. At the date of writing this microsporidian has been found in the following species and strains of fish: fall-spawning, domesticated rainbow trout, *S. gairdneri;* spring-

spawning, domesticated rainbow, *S. gairdneri;* wild, British Columbia rainbow, *S. g. kamloops;* wild steelhead rainbow trout, *S. g. gairdneri;* kokanee red salmon, *Oncorhynchus nerka kennerlyi;* and sculpin, *Cottus* sp. Other species of salmonids have not yet been examined in sufficient numbers to determine whether or not they harbor the parasite.

In wild steelhead rainbow the disease has been found in several coastal river systems, indicating that it may be widely spread through this subspecies.

Epidemiology. Up to the present time only two serious epizootics have been studied. It is possible that other epizootics caused by this microsporidian have occurred but were not diagnosed or were incorrectly diagnosed. One of the two cases mentioned above involved a group of about 170,000 advanced steelhead fingerlings. These fish suffered an almost complete loss. In the second case over three-quarters of a similar group of wild British Columbia rainbow fingerlings were lost. In all other occurrences of this disease in hatcheries the losses to date have been slight. However, the importance of this disease cannot be estimated on the basis of dead fish alone, for it probably acts as a predisposing factor to other disorders. It may also render transportation of hatchery trout more difficult and, finally, it seems reasonable to suppose that it reduces the survival of planted fish.

The extent of infection and the possibility of epizootics in wild populations can only be hypothesized. In a large sample from one quite typical coastal stream, three-quarters of the yearling steelhead examined were infected and nearly half of these were so heavily infected that their survival appeared doubtful.

Pathology. To the time of writing these protozoans have been found in the gill tissue only, but histological studies now in progress may show them to occur elsewhere.

The stages of the organism from early schizonts to mature spore cysts were found scattered throughout the tissue of the gill filaments. The number of such organisms in each filament varies greatly. In heavy infections very large numbers may occur, making up an important part, by volume, of the filaments. The spore cysts have not been commonly found in the gills of trout examined to date. In most population samples no spores were found and in such cases the identity of the early stages is obscure. This may account for the fact that the disease has not been recorded previously. The writers believe that they saw early stages many times before, but were unable to identify them. On the other hand, a sample from one hatchery population included many spore cysts and in this case the identification of this protozoan as a microsporidian was relatively simple.

The vegetative stages range from 5 μ in diameter for young schizonts to 15 μ x 40 μ for developing sporonts. Spore cysts range from 120 μ to 180 μ in diameter and the dimensions of the spores are 2.4 μ by 7.5 μ.

Heavily infected gill filaments commonly show moderate to great epithelial proliferation, with some inflammation but no joining of the filaments. In hatchery trout there is a good correlation between anemia (pale gills) and abundance of the organisms. However, in wild steelhead populations this has not been so pronounced.

In the more acute hatchery epizootics the dying fish lie quietly in shallow water of the ponds or descend to the lower ends, where death occurs quite rapidly and without pronounced loss of weight. External symptoms of the disease are not pronounced and might easily be confused with those of other diseases. Similarly, the pale gills can easily be confused with dietary anemia. Careful examination of the gill filaments under high-dry or oil immersion lenses is the only known method of diagnosis.

Class Sporozoa
Order Myxosporidia
Ceratomyxa shasta Noble

Occurrence. This protozoan was observed in 1948 by the writers in domesticated, fall-spawning rainbow trout, *S. gairdneri,* at Crystal Lake Hatchery, Shasta County. Material was submitted to Dr. Elmer R. Noble and was described by him as a new species (Noble, 1950). As pointed out by Noble, in part: "This is the first report of the genus *Ceratomyxa* in a fresh water fish, and the first report of the genus as a tissue parasite. Species of *Ceratomyxa* occur widely in marine fishes where they infect the lumen of gall and urinary bladders."

The disease has not been found in any other hatcheries or in any wild fish outside the immediate area of the hatchery. The original water supply to this hatchery was from springs in Crystal Lake. Attempts to eradicate the wild fish from the lake were unsuccessful and the epizootics continued until water from nearby Rock Creek was piped to the hatchery. Since this change was made the disease has not been a serious factor, although a few infected fish can be found each year.

At present it is not known why the disease is so serious when the fish are held in Crystal Lake water and almost absent when held in Rock Creek water. Both waters arise from springs about a mile apart.

It has been found only in rainbow trout, of both domesticated fall-spawning and spring-spawning stocks. It has not been found in the brook trout, *Salvelinus fontinalis,* nor in the brown trout, at Crystal Lake Hatchery.

Epidemiology. Certain lots of rainbow being held at Crystal Lake Hatchery have suffered total or nearly total losses. The disease usually became apparent in the fall and winter, when the fish were approximately 12 to 16 per pound in weight, although on several occasions smaller and larger fish were found infected. All attempts to transmit the disease from infected to uninfected fish have been unsuccessful.

Pathology. The disease is unusual in the number of tissues and organs where it may be found. The entire alimentary tract, the liver, gall bladder, spleen, gonads, kidney, heart, gills, and skin may be more or less infected. All layers of the hind gut are usually infected and greatly swollen in a manner which is quite characteristic.

Diseased fish become sluggish and seek quiet, shallow areas of the ponds or raceways. Frequently the coelom is much distended and the eyes protrude as a result of accumulations of ascitic fluid.

Fresh preparations of infected tissues disclose both trophozoites and spores of characteristic shape.

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NOTE

RIVER OTTER NOTED EAST OF SIERRAN CREST

On August 11, 1954, five river otter *(Lutra canadensis)* were observed by the writer at Poore Lake, near Pickle Meadows, Mono County, California. When first observed the otter were on the bank, but immediately took to the water. They surfaced less than 100 feet from shore and were under observation for several minutes on several occasions.

A search located two burrows. No slides were found, but the terrain is such that the construction of slides would have been impossible.

On some portions of the lake shore accumulations of droppings sufficient to create a fishy odor noticeable for a distance of several yards were present. These droppings contained a great many crayfish fragments and also remains of suckers, probably *Catostomus* sp. Specific identifications of the crayfish and sucker material have not yet been made.

The literature does not mention the occurrence of river otters on the eastern slope of the Sierra Nevada. Grinnell, Dixon, and Linsdale (1937) indicated that they are not found there.

REFERENCE

Grinnell, Joseph, Joseph S. Dixon, and Jean M. Linsdale
1937. Fur-Bearing mammals of California. [2 vol.] Berkeley, Univ. of Calif. Press, vol. 1, p. 271-285.

—John Laughlin, Game Management Branch, California Department of Fish and Game, November, 1954.

REVIEWS

The Elementary Chemical Composition of Marine Organisms

By A. P. Vinogradov (translated from the original Russian by Julia Efron and Jane K. Setlow, with bibliography by Virginia W. Odum); Sears Foundation for Marine Research, Yale University, New Haven, Conn., 1953; xiv + 647 p., 327 tables. $17.

This volume contains such a quantity of information as to render a page by page critical evaluation almost a physical impossibility. For this reason the present review will be confined to a discussion of content combined with comments of a general nature. This work is of such herculean aspect it is difficult to perceive how any one man could search out and compile, much less organize and present, the thousands of individual contributions which make up the whole. The Russian original appeared in three parts in 1935, 1937 and 1944, in the Travaux du Laboratoire biogeochimique de l' Academie des Sciences de l'USSR. The third part contained numerous additions to the subject matter treated in the two earlier parts and this information, along with that which appeared during the process of editing and preparing the English translation for press, have been combined in the present work.

The introduction is followed by 20 chapters which cover the organisms in major categories from planktonic and nonplanktonic algae through fishes which are associated with a marine habitat. The final two chapters are entitled: "The regulating influence of ocean salt on the chemical composition of marine organisms" and "Fundamental changes in the elementary composition of marine organisms during geological time." The bibliography, consisting of some 2,200 entries dating from the sixteenth century to 1951, is to a considerable degree the result of the labors of Mrs. Virginia Odum.

The subheadings listed for a typical chapter, "Elementary composition of mollusca," give an insight into the thoroughness with which the various phyla have been treated: 1. general remarks; 2. water, organic matter, and ash; 3. carbon, hydrogen, and nitrogen; 4. sodium, potassium, calcium, magnesium, phosphorus, sulfur, chlorine, and silicon; 5. sodium and potassium; 6. calcium and magnesium; 7. phosphorus, sulfur, and chlorine; 8. silicon; 9. composition of shells; other skeletal formations; 10. composition of shells of Cephalopoda; 11. composition of shells of Lamellibranchiata; 12. composition of shells of Amphineura, Scaphapoda, Pteropoda, and Heteropoda; 13. composition of skeletal parts of Gastropoda; 14. composition of pearls; 15. manganese, iron, copper, and zinc; 16. other metals; and 17. nonmetallic elements. The entire chapter, including 69 tables, is encompassed within 105 pages.

Undoubtedly this is one of the most important, if not the most important, contributions of its kind and should prove an extremely valuable reference for marine biologists, biochemists, physiologists, experimental zoologists, geologists, chemical oceanographers, and nutritionists. The original edition comprising 1,500 copies, printed in Denmark, is on rather substantial paper and appears to be strongly bound. The high price rather than the limited first printing will probably be the major factor affecting acquisition of this desirable volume by the average individual. —*John E. Fitch, California Department of Fish and Game.*

Family Circle's Guide to Trout Flies and How to Tie Them

By Anon.; Family Circle, Inc., New York, 1954; 48 p.; illustrated by G. Don Ray. Pliable water-resistant cover, $2; gift edition with board cover and slip case, $3.

Color plates of flies are especially desired by the fly-tyer who cannot always visualize a pattern from the written description. Unfortunately, in many books containing such plates, the descriptions have been placed too far away from the illustrations. Reproduction has often been fuzzy. Dry flies have seldom shown up well. And one of the main reasons why many of the past plates have not been wholly satisfactory is simply because the figures have not been large enough.

As if in answer, then, to these criticisms the Family Circle has issued this guide. Each of its 16 plates of flies is directly faced by a table giving a full description of the dressings. There are 152 patterns in all: 40 drys, 72 wets, 20 nymphs and 20 streamers. The color reproduction is true enough for its purpose, and the paintings are sharp. Most important of all, each of the figures is large enough so that one can see every detail clearly. Even the smaller flies are two inches long.

In addition to the fly plates there are four others showing 84 kinds of fly-tying materials.

The text is limited to nine pages, including the introduction and a step-by-step description of how to tie a wet fly. Readers will have to turn elsewhere for a detailed account of how to tie other types of flies. However, the book was not designed to be a complete manual; its principal value is as an illustrated dictionary. (Note to revisers: Please replace "claret" with "scarlet" in the descriptions of the Thor and Umpqua Special.)

This is such a good book that it is a shame to list its author as "Anon." An introduction by Raymond R. Camp states that the flies were selected by Jim Deren of Angler's Roost in New York. I presume that Deren also contributed the descriptions. The paintings are by G. Don Ray, who is also well known as an angler and who has illustrated several other angling books.

Incidentally, the cover will knock your eye out. Upon its white background is superimposed a Fan-Wing Royal Coachman in full color with over-all dimensions of 5 x 6½ inches. A fish might not rise to such a lure but most fishermen will.—*William A. Dill, California Department of Fish and Game.*

Amphibians and Reptiles of Western North America

By Robert C. Stebbins; McGraw-Hill Book Company, Inc., New York, 1954; xxii + 528 p., 104 plates, 52 text figs. $8.50.

The area covered by this volume is delimited on the south by the Mexican boundary and on the east by the eastern boundaries of New Mexico, Colorado, Wyoming, and Montana and the territories of Saskatchewan and Mackenzie. Full treatment is given to species which either have been or are found within this area, comprising 23 salamanders, 29 frogs and toads, 13 turtles (including three strictly marine), 57 lizards and 72 snakes. For each of these species there is detailed, up-to-date information on habitat, appearance, habits and biology.

Geographic distributions are presented for each species by outline maps at the end of each chapter. For those species which are wide ranging, small inset maps depict distributions beyond the general area encompassed by the term "Western North America."

This book, designed primarily to provide a stimulus to novices and beginning students in the field of cold-blooded vertebrates, will do just that, through rapid yet accurate means for identification and intimate insights into the lives of these often seen but poorly known groups.

An introductory chapter of 22 pages contains short sections full of useful information on such subjects as identification, use of names, descriptions, methods of collecting and preservation of specimens. The succeeding 487 pages are devoted to the two classes, Amphibia and Reptilia, and the several orders contained therein. There is a good glossary of some 125 entries and the entire volume is well indexed and beautifully illustrated with drawings by the author.

Some advanced taxonomists will doubtless take exception to the author's conservatism, especially with regard to his treatment of certain genera, species and subspecies. Such criticisms should, in the reviewer's opinion, be but a minority report in comparison with the approving comments of those individuals who for the first time find herpetology an understandable and readily assimilated science.

A copy of this fine work should grace the bookshelves of every naturalist, whether amateur or professional, and once purchased will, in time, become dogeared and worn from frequent usage. There can be little doubt that this new book has set the stage for rapid developments in the field of herpetology.—*John E. Fitch, California Department of Fish and Game.*

The Mammal Guide

By Ralph S. Palmer; Doubleday and Company, Inc., Garden City, N. Y., 1954; 384 p., illustrated by the author. $4.95.

The Mammal Guide covers the mammals found in North America north of Mexico. It is written expressly for the layman, contains a minimum of scientific terms, and is easy to read. It includes 250 figures in color, 37 line drawings, and 145 range maps.

This book combines field identification information with a concise section on the habits, behavior, and various life-history phases of each species. The inclusion of life-history data in an identification manual is commendable.

The life-history data are concise, but include the important facts for each species and will prove a valuable source of information for those who wish to learn the characteristics of our mammals. It is believed that the addition of dental formulae would have added to the usefulness of this book.

The illustrations, while adequate for identification, are not of top quality. They lack detail, some look as if they had been drawn from old museum specimens, and the color process does not bring out the tones and shades found in nature.

All of the color plates are grouped together in the center of the book. Some may prefer an arrangement in which the illustrations accompany, or are close to, the descriptions of the corresponding species.

This book and "A Field Guide to the Mammals" by W. H. Burt and R. P. Grossenheider, which was published in 1952, are the first North American mammal guides since Anthony's "Field Book of North American Mammals", published in 1928. Both of these recent books will have more appeal to those just starting out in the study of mammals than does Anthony's book.—*W. Macgregor, California Department of Fish and Game.*

Mammals of California and Its Coastal Waters

By Lloyd Glenn Ingles; Stanford University Press, Stanford, California, 1954; xiii + 396 p. illustrated. $6.

Professor Ingles is a topnotch field mammologist and this revised and improved edition of his earlier "Mammals of California" should become popular. This edition is in the more acceptable size of 9 by 6 inches. The text keys used in his earlier book have been replaced by excellent drawings, arranged in 25 pictorial keys, which provide quick and easy mammalian identification. An additional key based on skull drawings is designed to help more advanced students.

The contents include chapters on Introduction to Mammals, Mammals of Long Ago, Why We Study Mammals, and How to Study Mammals. The latter chapter covers the use of measurements; range maps; life zones, biotic communities, and habitats; and the use of mammalian keys. The chapter on Accounts of the Species includes all orders of mammals found in California and its coastal waters. This is the first time all of California's mammals have been described in one book. The individual species accounts contain many interesting life-history observations and personal experiences gained by Dr. Ingles during his more than 20 years of study of California mammals.

Besides the pictorial keys, good range maps are presented for all species whose ranges have been satisfactorily worked out. Thirty-six pen and ink drawings of the droppings of the more common mammals are included in the section on Scats.

The Appendix consists of 60 pages of data on How to Collect and Make up Study Skins, Dental Formulae of the Genera of Land Mammals of California, an Artificial Generic Key to the Skulls of California Mammals, Scats, Pronunciation of Some Mammalian Genera, Principles of Zoological Classification and Classification and Check List of Native and Introduced Species of Recent Mammals of California.

Mammals of California and its Coastal Waters is an outstanding work and one which will greatly increase interest in mammal study by the layman, the vacationist, and the student at all levels and will also be of value to conservationists and wildlife administrators who wish a good reference book on the subject.—*John B. Cowan, California Department of Fish and Game.*

Forestry

By H. G. Champion; Oxford University Press, New York, 1954; vi + 230 p., $1.

In essence this pocket-size volume is a survey course in world-wide forestry practices. The field of forestry is extremely broad and the author has successfully touched upon each phase in a nontechnical manner. Probably the most interesting phase to an American is the explanation of the silvicultural practices of Europe and India. In the latter country a Forest Service has been extant since 1868, while forestry as a state function in England did not begin until the Forestry Act of 1919 provided for a Forestry Commission. In general, countries other than Canada and the United States date their professional forestry from the time that reforestation methods were initiated.

A rather complete bibliography has a very useful presentation—the references are listed by chapter of occurrence, a welcome arrangement for the serious student. —*Henry A. Hjersman, California Department of Fish and Game.*

Fishes of the Western North Atlantic. Part Two. Sawfishes, Guitarfishes, Skates, Rays and Chimaeraids

By Henry B. Bigelow and William C. Schroeder; Sears Foundation for Marine Research, Yale University, New Haven, 1953; xv + 588 p., 2 maps, 127 figs. $15.

Five years have elapsed since the publication of Part One of this monumental work covering the area of the Western North Atlantic between Hudson Bay and the Amazon River. The very high standard set by the first volume has been carried through with the same meticulous care in the second.

In each chapter of the present book there is a very informative discussion of the group and such general facts as are known concerning characters, respiration, locomotion, breeding and development, habits and food, relation to man and general distribution.

Large groups down to genera are arranged in a sequence which represents their probable relationships. Within the genus, species are arranged in alphabetical order. For each species, available data have been organized under the following headings: study material, distinctive characters, description, color, size, developmental stages, habits, relation to man, range, occurrence and synonyms and references. Occasionally such items as food, relation to other species, numerical abundance, abnormalities and remarks are included.

The keys are dichotomous and wherever possible refer to characters which are external and easy to see. The first major key offers a breakdown to suborders; thereafter, keys to families, genera and species are to be found within the proper sections. All families and genera currently accepted have been included and extralimital keys are given for the species within the genera *Pristis*, *Zapteryx*, *Torpedo*, *Narcine*, *Diplobatis*, *Benthobatis*, *Cruriraja*, *Springeria*, *Chimera* and *Hydrolagus*.

In the first chapter (sawfishes, guitarfishes, skates and rays) 62 species representing 24 genera and 12 families are included. Study material was available for all but two of these species. Since the book was published, however, the authors have described elsewhere two further species, *Pseudoraja fischeri* and *Raja fuliginea*, which were taken by deep trawling in the Gulf of Mexico. The first of these, named in honor of E. N. Fischer, who prepared a great majority of the drawings in the present volume as well as in Part One, also represents a new genus and family.

The second chapter (Chimaeroids) details information on four species from four genera and three families. Here again a recent discovery adds an unincluded species and genus, *Rhinochimaera atlantica*, to the list of known forms from the Western North Atlantic.

An "Addendum to *Raja erinacea*" by Daniel Merriman, Yngve H. Olsen, Sarah B. Wheatland and Louva H. Calhoun contains some of the most interesting information ever published on skates. This summarizes preliminary conclusions drawn from detailed studies and examinations of over 15,000 *Raja erinacea*. These skates were obtained at monthly or more frequent intervals on a year round basis and there is little concerning their lives that was not investigated. Mating, fertilization, ovulation, hatching, growth rates, ages, relative abundance, food, and weight-length relationships are all discussed in some detail.

The authors, the editor-in-chief (John Tee-Van) and all others connected with the bringing out of this much needed work are to be heartily congratulated for a fine job well done. It should be the ambition of every student of fishes to own a personal copy of this monumental work.—*John E. Fitch, California Department of Fish and Game.*

The Way to Better Angling

By W. G. Greenaway; The McBride Company, New York, 1954; xii + 214 p., illus. $3.50.

"The Way to Better Angling" is a fishing book and not a treatise on the improvement of fishing.

The author, who now lives in Nova Scotia, gained his first experience in the British Isles, and this background has greatly influenced his writing. As he says, one of his purposes is to create a desire for English and Scottish angling methods, where skill plays the greater part. Much of the equipment he mentions, as well as his vernacular, is British. For example, he uses the "new" numbers for hook sizes. Most American anglers are unaware that they are still using the "old" ones.

The chapters are as follows: one each on Atlantic salmon fishing, greased line fishing, trout fishing, lake fishing, striped bass fishing; four on equipment; one on salmon flies; and a final potpourri. There are a few diagrams and tables and a color plate of salmon flies. Most of the book is on fly fishing, but trolling, plugging, bait fishing and spinning are also treated. Incidentally, the author points out—what few Americans realize—that "threadline fishing" is the proper term for what we now call "spinning." The latter, in its original sense, was carried on with either a revolving- or a fixed-spool reel.

According to the author, his original intention was not to write a book but merely to make a few notes which could be passed on to other fishermen. He has completed a book, but it is still a collection of personalized notes. Some blank spots need to be filled in, repetitions eliminated, and a few mistakes corrected. For example, the striped bass (*Roccus saxatilis*) is not found in England or Wales (p. 130). Perhaps he meant the gray bass, *Morone labrax?*

This is not a book for the beginner; it is too disconnected for that. Rather it is a book for one who is already an angler—anxious to extend his knowledge or to controvert the theories of another. Major Greenaway is undoubtedly an excellent fisherman and has presented some excellent ideas. He has also included some folk tales. It is up to the reader to separate the two.—*William A. Dill, California Department of Fish and Game.*

The American Angler

By A. J. McClane; Henry Holt and Company, Inc., New York, 1954; ix + 207 p., illus. $5.

Sometimes one marvels at this fellow, McClane. He seems to be using up his material as fast as TV is reputed to, and yet he can always produce more. Furthermore, it's good. Now, he has written a book subtitled, "Where to find and how to catch prize-winning fresh-water game fish."

As a basis for this, he has analyzed the *Field and Stream* fishing contests for the past 10 years, and from these has provided us with such information as: the waters most apt to provide big fish, the best months to fish them, and the best lures to use for prize winners.

Let's see how this works. Suppose you want a lunker rainbow? Simply refer to his table on page 78 and you'll wind up fishing at Lake Pend Oreille in November. After all, during the last 10 years four-fifths of the largest prize winners have come from that one lake.

"But," you may say, "Idaho's a long way off. All of those fish were caught on hardware, and I'm a purist." Well, California took 41 prizes in the fly casting division for rainbows, with one up to 20 pounds. How about brown trout? We placed 10 in the fly casting division and 21 in the open division. During the last 10 years California took first and second place for brown trout; first and second for largemouth bass in the northern division; sorry to say, we have had only one prize winner among the brook trout. See how useful his tables are?

Along with such statistics McClane has dished up a dizzying array of other facts, figures, and photos—spiced with anecdotes, and travel notes, techniques, recipes, and even a few discourses on systematic ichthyology.

There are mistakes here and there, of course. For example—and considering California alone—one hardly thinks of Alameda Creek as a smallmouth stream; the Kern is given undue prominence; and High Sierran fishing is represented as a little more rugged than it really is. But with such a wealth of material to present, who could be perfect?

Now, let's go back after the big fish again. This is a good book but don't try to relax with it. McClane is a fast writer and you'll have to read rapidly to keep up with him.—*William A. Dill, California Department of Fish and Game.*

Steelhead to a Fly

By Clark C. Van Fleet; Little, Brown and Company, Boston, 1954; viii + 275 p., maps. $4.

This is a book of the summer steelhead streams—of their riffles and breaks, their slicks and their hot spots. It is a book of fishing and its techniques. It is one of reminiscence and anecdote. Finally, it is a book of anger at those who would despoil these waters.

The author is an angler of the older school. He clings to the double-tapered line and gut leader, scorns the "tournament" rod, and ignores today's use of shooting heads and monofilament. He is no advocate of extreme distance, believes that the steelhead takes a fly because it is hungry, and that control and delicacy in casting are highly important.

In explaining his theories and methods he divides the book into two sections. The first contains chapters on the fish himself, how to find him, equipment, wading, light and color, and the cardinal principles of successful fishing. The second part is devoted to the summer- or fall-run streams—the ones with which the fly fisherman is most concerned.

Van Fleet discusses four major rivers, the Eel, Klamath, Rogue, and North Umpqua, in great detail; gives lesser attention to waters such as the Kalama, Wind, and Trinity; and devotes one chapter to winter bait fishing on the Russian River. The White Salmon is included erroneously as a summer-run stream (why not the Klickitat?), and there is no mention of the Sacramento. The latter is no fly stream, it is true, but its summer or fall run is developing rapidly.

Tables listing resorts and other accommodations on the major streams are given. The illustrations are diagrammatic maps showing the summer steelhead streams or the riffles in certain sections of them. These are by no means complete. For example, the only Klamath riffles shown are those between Weitchpec and Wallace Creek, and the map of the lower Rogue omits the many riffles near Agness.

A short section is devoted to the life cycle of the steelhead, and references to its life history are frequent throughout the book. Some of the statements made in this section are too inclusive. A few are definitely misleading. However, the life history of this sea-run trout can be quite varied or complex. Rather than to try to point out defects in this book's account, the reader is referred to the Department of Fish and Game's latest Fish Bulletin, No. 98, on the life history of the steelhead and silver salmon—a publication which at the time was not available to the author.

The writing is uneven. Occasionally it is difficult to understand, and it is not without its cliches. However, the general level is high, and there is always a fine feeling and love for the subject. It is an interesting, enthusiastic, and very useful book.

The last chapter, "What of Tomorrow's Fishing?" is centered on the effects of dams and water diversions on anadromous fishes. The Bureau of Reclamation, Corps of Engineers, and the California State Division of Water Resources are all suspect and damned. Unfortunately, and perhaps in his indignation, the author has not verified or brought all of his statistics up to date. For example, corrections appear necessary to the following figures: Central Valley run-off is 33 million acre-feet, not 45 million (p. 267); Klamath Basin run-off is 13 million acre-feet, not 9 million (p. 267); "excess" at the proposed Ah-Pah Dam is closer to six million acre-feet than to two and one-half million (p. 268). One might also take issue with several other figures, such as his 90 percent run-off coefficient of the Klamath (p. 268), which is actually closer to 55 percent.

He is rather harsh in his criticism of California's regulations, forgetting, perhaps, that the Klamath River initiative (which prohibited the construction of dams below the mouth of the Shasta) was passed in 1924, long before any similar steps were taken in other states.

Van Fleet proposes the idea that waters of the Trinity and Klamath can now be preserved for fish through the doctrine of riparian water rights. He is mistaken in this. Rights require use and cannot be secured for a flowing stream.

The reviewer is highly sympathetic with Van Fleet's desire to see our northern rivers preserved as steelhead streams. He regrets only that the facts are not always accurate; for, like the author, he too hopes that "* * * please, God, they will continue to congregate with their noses upstream, their eye out for a surface lure cunningly presented, their rise to the dainty a slashing show of silver belly. Then may your reel smoke hotly, your heart choke your breathing as the line melts away, and

your rigging held together at his thrashing jump; to the end that you slide him ashore with a prayer of thanksgiving and a burning of incense. No greater gift can you expect from Nature than a fresh-run steelhead."—*William A. Dill, California Department of Fish and Game.*

American Game Birds of Field and Forest

By Frank C. Edminster; Charles Scribner's Sons, New York, 1954; xx + 490 p.; 99 black and white photos + 30 plates. $12.50.

This book covers 17 species of birds that are important in upland game hunting throughout the Nation.

A chapter is devoted to each species with the exception of the Gambel's, mountain, and scaled quails, which are combined in one chapter. The other species covered are; ring-necked pheasant, wild turkey, sage grouse, sharp-tailed grouse, prairie chicken, ruffed grouse, bob-white quail, California quail, chukar partridge, Hungarian partridge, American woodcock, band-tailed pigeon, mourning dove, and white-winged dove.

All but five of these species are now found in California, and the sharp-tailed grouse was formerly present in the State. Currently hunting seasons are in effect in California for nine of the species covered.

All chapters follow the same arrangement, and when the reader has finished one chapter he will be able to find any information he wants for other species quickly and easily. For each species there are sections on origin and history, geographic range, description, importance as a game bird, habits, shelter requirements, food habits, effects of weather and climate, predation, relation to man, reproduction and populations, and management. A life equation table is given for each species. Bibliographical notes corresponding to each chapter are grouped at the end of the book.

The author says in the preface that he hopes he has not made it seem that our knowledge of these game birds is thorough, because it is not. If the reader does not read this admonition in the preface he will certainly gain the impression that more is known about life-history and population dynamics than is actually the case.

The author is certainly to be commended for the excellent job he has done in bringing together a wealth of information about these birds. The information is up to date. Many of the recent data were drawn from the "Pittman-Robertson Quarterly."

There are some errors in the geographic range maps as they concern California. The map of chukar distribution fails to show some of the best chukar populations in the State, and the pheasant map shows the whole Central Valley as an area of best pheasant habitat, whereas less than half of it is good. The presence of wild turkeys in California is not mentioned, although they have been present in the State since their introduction in 1928. We now have several well-established populations, although there has never been an open season on turkeys in California. There are some typographical errors in the bibliography. These errors are small and of little significance when compared to the excellent presentation throughout the book. The text is concise, reads easily and the photographs and figures are abundant and do a good job of illustrating the points involved. The book is an attractive one and should serve as an excellent reference to persons interested in upland game birds. It is written so that it can be read and enjoyed by the sportsman and naturalist, but it has not been sugared down, and has a wealth of ecological information.—*Wallace Macgregor, California Department of Fish and Game.*

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